

QUALITY ASSURANCE PROJECT PLAN

FOR THE

Scott Air Force Base

EPA Region 5 Records Ctr.



356947

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ATTACHMENT 1

**LABORATORY
QUALITY ASSURANCE PLAN**

The information contained in this attachment was compiled solely by Weston Analytics, Lionville, Pennsylvania, for use in ERM, Inc's, Phase II/IVA QAPP. ERM has not altered any procedures or protocols described herein.

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1. Introduction

The purpose of this project is to provide Environmental Resources Management, Inc. (ERM) with analytical support associated with investigations of the Scott Air Force Base under the Air Force Installation Restoration Program. In preparation for this task ERM has contracted with WESTON Analytics (WESTON) for analytical services.

This document describes the Quality Assurance (QA) procedures that will be used by WESTON in conducting analyses of Scott Air Force Base samples. In summary, WESTON will perform analyses of target compounds using the methods specified in Table 5 of ERM's field QAPP.

2. Organization Chart and Individual Responsibilities

2.1 Introduction

The organization of WESTON Analytics is shown in Figures 2-1 and 2-2. The specific duties and responsibilities of the Laboratory Manager, Quality Assurance Coordinator, Section Managers, Project Manager, Project Director, and Technical Director are described in detail in the relevant standard operating procedures (SOPs). These duties and responsibilities are summarized in the following sections.

2.2 Project Director and Project Manager

WESTON recognizes the importance of efficient project management. WESTON has established a Project Director-Project Manager group which is responsible for managing all analytical projects. Mr. Norm Flynn is the WESTON Analytics Project Director. Ms. Judy Stone is the Project Manager for this project. Ms. Stone is responsible for maintaining the laboratory schedule, ensuring that technical requirements are understood by the laboratory, and ensuring that project deliverables are submitted on-time and in the required format.

2.3 Technical Director

The WESTON Analytics Division Technical Director is Dr. Earl Hansen. He will serve as project director and technical liaison for this project and will assist in resolving any technical issues. He will coordinate these activities with the Project Manager and Quality Assurance Coordinator.

2.4 Laboratory Manager

The Lionville Laboratory Manager is Dr. Carter Nulton. He has the responsibility to see that any tasks on this project are conducted according to the requirements of ERM and this Quality Assurance Project Plan (QAPP).

2.5 Section Managers

The responsibilities of the Section Managers are summarized below:

1. Provide technical direction to analysts in conformance with project requirements.
2. Monitor laboratory work schedules to ensure compliance with project commitments.
3. Review all analytical data prior to reporting to ensure conformance with this QAPP and the Task Order.
4. With the Laboratory Manager and Quality Assurance Coordinator, identify and resolve technical problems consistent with the requirements of this QAPP.
5. Ensure that assigned personnel are adequately trained to perform analyses required by this contract.

2.6 Chemists-Technicians

An effective laboratory quality assurance program depends on the performance of all laboratory staff who perform analyses. The responsibility of laboratory chemists and technicians include:

1. Initial review of QC data for acceptability.
2. Recording of data in bound laboratory notebooks (including any observations made during the analyses).
3. Informing direct supervisors of any problems with instruments or methods to ensure that prompt and effective corrective action is taken.

2.7 Quality Assurance Coordinator

The laboratory Quality Assurance Coordinator is Ms. Dianne Therry. She has oversight responsibility for the quality assurance objectives of this contract.

FIGURE 2-1
WESTON ANALYTICS DIVISION
ORGANIZATIONAL CHART

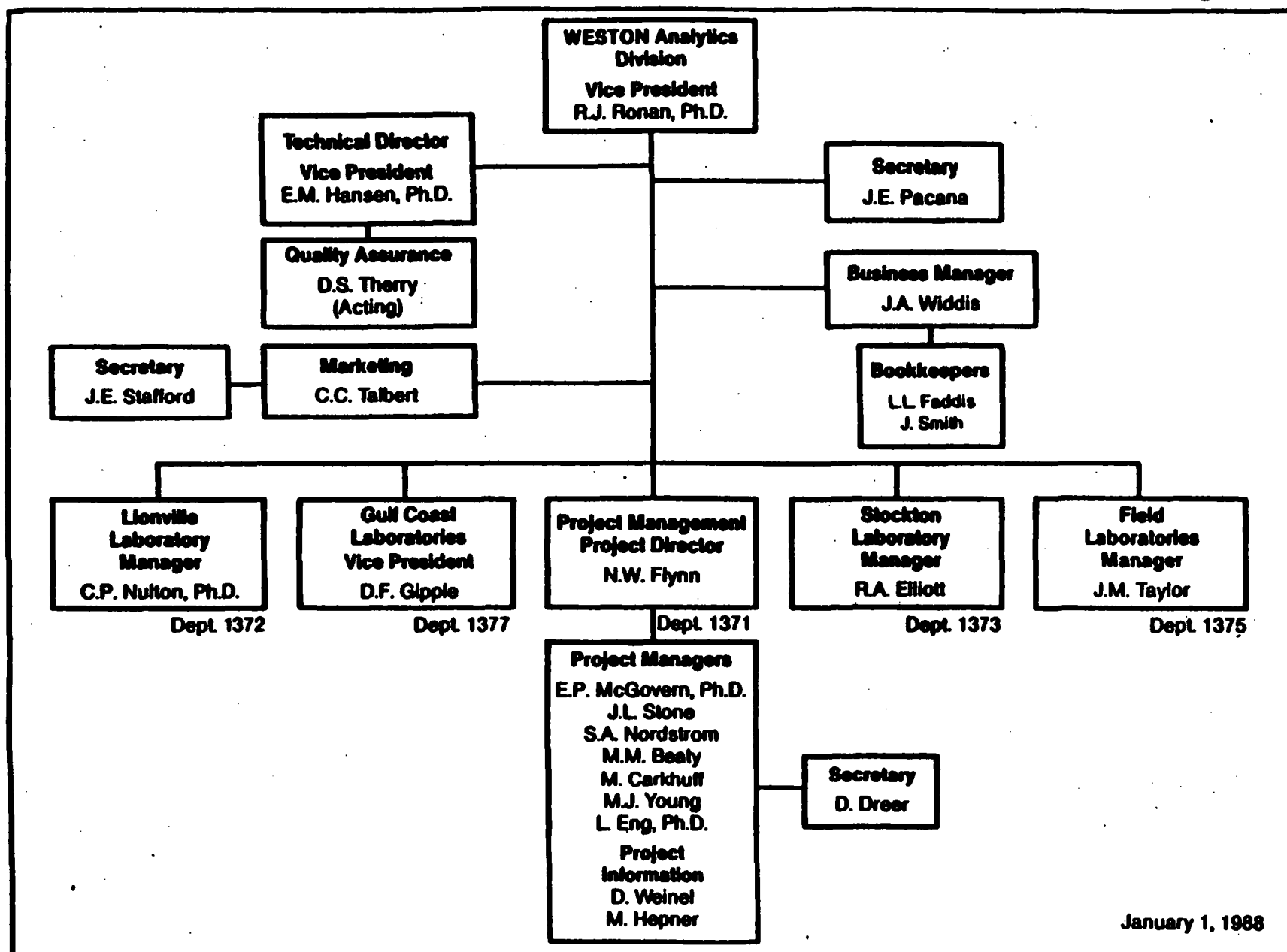
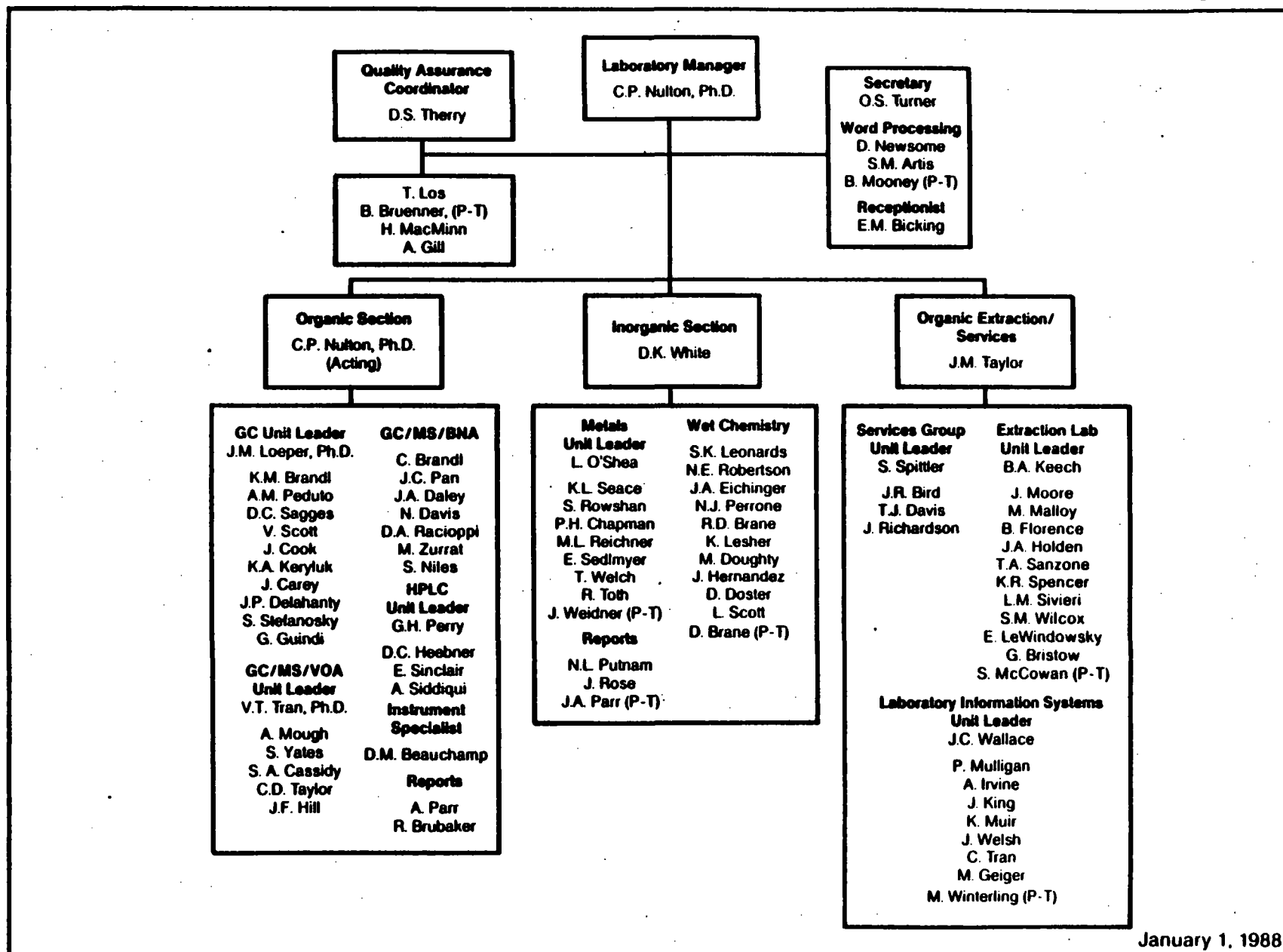


FIGURE 2-2
LIONVILLE LABORATORY
ORGANIZATIONAL CHART



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LIONVILLE LAB - DEPT. 1372

Figure 2-2

2.8 Data Manager

Mr. James Wallace is the Lionville Laboratory Data Manager. He is responsible for monitoring the status of all samples in the laboratory and ensuring that data are reported in a timely manner and in the proper format.

3. Quality Assurance Objectives

3.1 Introduction

The objective of this Quality Assurance Project Plan is to provide a framework to ensure that all analytical data which are reported are of known quality. The minimum requirements of an effective Quality Assurance program include:

- Bottle Preparation and Sample Preservation
- Chain-of-Custody Procedures
- Instrument Calibration and Maintenance
- Personnel Training
- Laboratory Quality Control Procedures
- Data Review, Validation and Reporting
- Sample Retention and Disposal

All measurements made in this program will be representative of the matrix and conditions being measured. The data will be calculated and reported in units consistent with standard reporting conventions.

The specific procedures utilized by WESTON for these systems will be described in subsequent sections of this QAPP. All of these systems help to establish the objectives of accuracy, precision, and completeness.

3.2 Quality Assurance Objectives for Accuracy

Analytical accuracy is expressed as the percent recovery of an analyte (or a surrogate in the case of organic analytes) which has been added to the sample (or standard matrix, i.e., blank surrogate) at a known concentration before analysis and is expressed by the following formula:

$$\text{Accuracy} = \% \text{ Recovery} = \frac{AT - AO}{AF} \times 100\%$$

where:

- AT = Total amount found in fortified sample
- AO = Amount found in unfortified sample
- AF = Amount added to sample

3.2.1 Inorganic Analysis

For metals, analytical accuracy is measured from analysis of a laboratory control standard and a sample fortified with the element of interest. The QA objectives for accuracy in metals analysis for these QC samples are taken from the U.S. EPA Contract Laboratory Program Statement of Work (SOW) and are summarized below:

<u>Sample</u>	<u>Recovery (%)</u>
Laboratory Control Standard (LCS)	80-120
Fortified Sample	75-125

The laboratory control standard consists of reagent grade water spiked with the analyte of concern which is carried through all the steps in the analytical method. The laboratory control standard is designed to serve as a monitor of the accuracy (recovery efficiency) of the analytical method. If the laboratory control standard QA objective guidelines are exceeded, the laboratory will use established U.S. EPA guidance to assess the impact on the usability of the data as well as the need for reanalysis. For example, the U.S. EPA Contract Lab Program (CLP) has dropped the laboratory control standard control windows for silver (Ag) and antimony (Sb) due to documented difficulties in the required U.S. EPA methodology to achieve consistent and reliable recoveries.

The fortified sample is an aliquot of a field sample which is fortified (spiked) with the analytes of interest and analyzed with an associated sample batch. The fortified sample is designed to serve as a monitor for assessing the affect of the sample matrix on measurement methodology. Established U.S. EPA guidance does not require reanalysis if the QA objective guidelines are not met.

3.2.2 Organic Analysis (GC and GC-MS)

For organic analysis, analytical accuracy is obtained from the surrogate recovery measured in each sample and blank and/or from the analysis of samples or blanks which have been fortified with a select number of target analytes.

The Quality Assurance objectives for accuracy for surrogate recovery are summarized in Table 3-1 and for recovery from fortified samples are given in Table 3-2. The recovery values for surrogate and target analytes in field sample analyses are advisory for routine laboratory analysis. Only recovery values for standard matrix samples (e.g., blanks) are used for triggering corrective action.

3.3 Quality Assurance Objectives for Precision

Analytical precision is calculated by expressing as a percentage the difference between results of analysis of duplicate samples relative to the average of those results for a given analyte. Precision can be expressed by the formula:

$$RPD = \frac{C1 - C2}{(C1 + C2) - 2} \times 100\% \quad \text{where}$$

RPD = Relative Percent Difference

C1 = Concentration of analyte in sample

C2 = Concentration of analyte in replicate

TABLE 3-1
 QUALITY ASSURANCE OBJECTIVES FOR ACCURACY
 FOR
 ORGANIC SURROGATE ANALYSES

<u>Fraction</u>	<u>Surrogate Compound</u>	<u>Percent Low-Medium Water</u>	<u>Recovery Low-Medium Soil-Sediment</u>
VOA	Toluene-d8	88-100	81-117
VOA	4-Bromofluorobenzene	86-115	74-121
VOA	1,2-Dichloroethane-d4	76-114	70-121
BNA	Nitrobenzene-d5	35-114	23-120
BNA	2-Fluorobiphenyl	43-116	30-115
BNA	p-Terphenyl-d14	33-114	18-137
BNA	Phenol-d5	10- 94	24-113
BNA	2-Fluorophenol	21-100	25-121
BNA	2,4,6-Tribromophenol	10-123	19-122
<u>Pesticides Dibutylchloredate</u>		<u>24-154*</u>	<u>20-150*</u>

* These recoveries are advisory only.

TABLE 3-2
QA OBJECTIVES FOR ACCURACY AND PRECISION
FOR
ORGANIC ANALYSES

Fraction	Matrix Spike Compound	Percent Recovery Limits		RPD Limits	
		Water	Soil-Sed	Water	Soil-Sed
VOA	1,1-Dichloroethene	61-145	59-172	14	22
VOA	Trichloroethene	71-120	62-137	14	24
VOA	Chlorobenzene	75-130	60-133	13	21
VOA	Toluene	76-125	59-139	13	21
VOA	Benzene	76-127	66-142	11	21
BN	1,2,4-Trichloro- benzene	39- 98	38-107	28	23
BN	Acenaphthene	46-118	31-137	31	19
BN	2,4-Dinitrotoluene	24- 96	28- 89	38	47
BN	Pyrene	26-127	35-142	31	36
BN	N-nitroso-di-N- propylamine	41-116	41-126	38	38
BN	1,4-Dichlorobenzene	36- 97	28-104	28	27
Acid	Pentachlorophenol	9-103	17-109	50	47
Acid	Phenol	12- 89	26- 90	42	35
Acid	2-Chlorophenol	27-123	25-102	40	50
Acid	4-Chloro-3-methyl- phenol	23- 97	26-103	42	33
Acid	4-Nitrophenol	10- 80	11-114	50	50
Pest.	Lindane	56-123	46-127	15	50
Pest.	Heptachlor	40-131	35-130	20	31
Pest.	Aldrin	40-120	34-132	22	43
Pest.	Dieldrin	56-126	31-134	18	38
Pest.	Endrin	56-121	42-139	21	45
Pest.	4,4-DDT	38-127	23-134	27	50
PCB	Arochlor 1254	Not Established		30	50

RPD = Relative Percent Difference

* The list provided includes those compounds most commonly used for QA/QC precision control in the groups of analytes shown based on current U.S. EPA Contract Laboratory Program (CLP) requirements. Stated control limits will be updated to the current CLP protocol, as required.

3.3.1 Metals Analysis (Inorganic)

For metals and other inorganic analyses the QA objective for precision is $\pm 20\%$ relative percent difference (RPD) between replicate analyses. Only precision values for standard matrix samples (e.g., lab control standards) are used for triggering corrective action. The precision values for field sample analyses are advisory only and are largely dependent on sample homogeneity.

3.3.2 Organic Analyses (GC, GC/MS)

For organic analyses, precision is measured by comparison of the recovery of surrogate compounds in the standard matrix (e.g., blank, blank spike) and/or by comparison of the recovery of a select number of target analytes in duplicate samples or blanks (e.g., matrix spike, matrix spike duplicate). The QA objective (expressed by the RPD for analysis of matrix spike and matrix spike duplicate samples) are given in Table 3-2. These RPD limits are advisory only for field samples. Only evaluation of precision for standard matrices will trigger corrective action.

3.4 QA Objective for Data Completeness

Completeness is a measure of the relative number of analytical data points which meet all the acceptance criteria for accuracy, precision, and any other required criteria by the specific analytical methods used.

The WESTON QA objective for completeness on this project is 85%. The ability to meet or exceed this completeness objective is dependent on the applicability of the analytical methods to the sample matrices analyzed.

4.0 Required Containers, Preservation Techniques, Holding Times

All samples submitted for analysis on this project will be collected by ERM personnel. Sampling containers and preservatives will be provided on request by WESTON Analytics. The specific requirements for sample containers, preservatives and analytical holding times are discussed in the following sections.

4.1 Sample Containers

Upon request from ERM, WESTON will provide, within 7 days, the required number and type of sample containers for a specific sampling episode.

All containers provided by WESTON will be obtained from I-Chem, Hayward, California, or be of equivalent quality. I-Chem is the bottle contractor to the U.S. EPA-Contract Laboratory Program. These containers are cleaned by I-Chem in accordance with U. S. EPA protocols. The containers purchased from I-Chem are I-Chem Series 200 containers. Each lot of these containers is analyzed in accordance with I-Chem quality control requirements and is not shipped by I-Chem unless the QC requirements are met. The types of containers provided for the analytes of interest are listed in Table 8 of the field QAPP along with the holding times and preservatives required for each analysis.

All sample containers provided by WESTON will be shipped with Chain-of-Custody sheets (see Section 5). These Chain-of-Custody sheets will be completed by the field sampling personnel and returned with the samples.

4.2 Sample Preservation and Holding Times

The preservatives required for all analyses will be provided by WESTON with the sample containers. The required preservation methods will be in accordance with those given in 40 CFR, Part 136, No. 209, October 26, 1984, for water and in SW-846, Third Edition, 1986, for soils.

The holding times for all required analyses are measured from sample collection and are given in Test Methods for Evaluating Solid Waste, November 1986, SW-846, Third Edition.

Upon sample receipt at the WESTON Laboratory all sample collection dates are noted by the sample custodian. The required date for completion of analysis (or extraction) is noted on the Chain of Custody sheet (see Section 5) and is keyed to the holding time if it falls sooner than the required reporting date for analyses. All analyses which have holding times of 48 hours or less are identified by the sample custodian and the appropriate section manager and analyst are notified that samples are in house.

4.3 Sampling Procedures

Sampling procedures are discussed in ERM's field QAPP.

5. Chain-of-Custody

5.1 Introduction

The purpose of chain-of-custody procedures is to document the history of sample containers and samples (and sample extracts or digestates) from the time of preparation of

sample containers, through sample collection, shipment and analysis. An item is considered to be in one's custody if:

1. it is in the physical possession of the responsible party,
2. it is in the view of the responsible party,
3. it is secured by the responsible party to prevent tampering, or
4. it is secured by the responsible party in a restricted area.

As discussed in Section 4, when sample containers are provided by WESTON, chain-of-custody documentation (see Figure 5-1) will be shipped with the sample containers. These forms will be completed by field personnel, with acknowledgment of time and date of transfer and placed in the shipping container in the plastic Ziploc container provided.

The following sections describe chain-of-custody procedures associated with sample receipt, storage, preparation, and analysis and general security procedures.

5.2 Sample Receipt

A designated sample custodian is responsible for samples received at WESTON. This individual is trained in all custody requirements and the potential hazards of dealing with hazardous waste materials. In addition to receiving samples, the sample custodian is also responsible for documentation of sample receipt, storage before and after sample analysis, and eventually the proper disposal of samples.

1. Upon receipt, the sample custodian will inspect the sample container for integrity. The presence of leaking or broken containers will be noted on the chain-of-custody form (see Figure 5-1). The sample custodian will sign (with date and time of receipt) the chain-of-custody form, thus assuming custody of the samples. If chain of custody forms are not included, the sample custodian will initiate these forms.
2. The information on the chain-of-custody form will be compared with that on sample tags and labels to verify sample identity. Any inconsistencies will be resolved with the field sampling representative before sample analysis proceeds.

3. Samples will be moved to one of the locked sample storage refrigerators (maintained at 4 ± 2 oC) for storage prior to analysis. The storage location will be recorded on the chain of custody form.
4. The sample custodian will return the original chain-of-custody form to the Laboratory Data Manager and provide copies to each laboratory Section Manager, one to the Project Manager, and one to the main sample log kept in the laboratory.
5. The sample custodian will alert appropriate section managers and analysts of any analyses requiring immediate attention because of short holding times.
6. The sample custodian will log the sample information into the Laboratory Information Management System (LIMS). These data include laboratory number, field sample number, dates collected and received, project-client identification, and parameters to be analyzed.

5.3 Sample Storage

Samples will be maintained in storage in one of the locked storage refrigerators prior to sample preparation and analysis.

Storage refrigerators are maintained at $4^{\circ} \pm 2^{\circ}\text{C}$. The temperature is monitored by the laboratory security system and recorded daily in a bound log by the sample custodian. If during working hours, equipment failure (compressor failure, door left open, etc.) results in the temperature of the storage refrigerator exceeding the upper or lower control limits, an audible alarm will sound and the samples will be moved to suitably controlled storage until the problem has been corrected. During off working hours, the alarm is automatically transferred to the security agency who alerts (via beeper call) laboratory and maintenance personnel so that prompt corrective action can be taken.

Analysts request samples for analysis from the sample custodian. Both sign the chain of custody acknowledging transfer of custody to the analyst.

5.4 Sample Tracking

The standard operating procedures for sample tracking are described in detail in WESTON SOPs. They are summarized in this section.

FIGURE 5-1

WESTON CUSTODY TRANSFER-WORK REQUEST FORM

Custody Transfer Record/Lab Work Request

Received By _____

Client _____

RFW Contact_____

Date _____

Client Contact _____

Date Due _____

Assigned to _____

Phone _____

Project Number _____

SAMPLE IDENTIFICATION

ANALYSES REQUESTED[illegible]**SPECIAL INSTRUCTIONS:**[illegible]**CUSTODY TRANSFER RECORD/LAB WORK REQUEST**

Figure 5-1

WESTON

5.4.1 Organic Analysis

For samples that require extraction prior to analysis, a sample extraction record is prepared at the time of extraction. A copy of this form is shown in Figure 5-2.

When samples are extracted for analysis by gas chromatography, GC/MS, or liquid chromatography, all pertinent data are entered on the sample extraction form and recorded in a bound laboratory notebook. Data are entered onto the form via computer by the person performing the extraction as the extraction proceeds. A hard copy of the form is printed out and is used as the vehicle for custody transfer to the analyst. Copies are provided to the analysts to inform them that extracts are ready for analysis. The bound laboratory notebook is kept in the laboratory.

Extracts are maintained by the Sample Preparation Section in refrigerated storage until transferred to the Analysts.

5.4.2 Metals Analysis

Samples are received by the Sample Preparation Section for digestion prior to analysis for metals by Atomic Absorption-Inductively Coupled Plasma Spectroscopy. When samples are prepared for digestion, the preparation Technician fills out a Sample Digestion Record shown in Figure 5-3.

All information regarding sample digestion is entered onto the sample digestion record via computer as the digestion proceeds and recorded in a bound laboratory notebook. The digestion record is maintained to acknowledge custody transfer of digestates to the metals analysis section. Upon completion of sample digestion, a copy of the sample digestion record is provided to the metals analysis section to alert them that digestates are ready for analysis.

The original copy of the digestion record is affixed to the bound laboratory notebook and is retained by the sample preparation section.

5.4.3 Record Keeping

Data related to all sample preparation and analysis procedures and observations by laboratory analysts are recorded in bound laboratory notebooks which are issued by the Laboratory Quality Assurance Coordinator. Laboratory notebook pages are signed and dated daily by laboratory analysts. Corrections to notebook entries are made by drawing a single line through the erroneous entry and writing the correct entry next to the one crossed out. All corrections are initiated and dated by the analyst.

5.4.4 Building Security

The WESTON Laboratory maintains controlled building access at all times. During working hours all non-WESTON laboratory personnel are required to sign in with the receptionist and are escorted by laboratory personnel while in the building.

The laboratory is locked between the hours of 5:00 p.m. and 8:00 a.m. Monday through Friday and during the weekend. The building is secured during non-working hours by an ADT Security System. This security system not only monitors building access but also monitors the temperature in the sample storage refrigerators. If the control temperature range is exceeded during working hours, an audible alarm sounds. During non-working hours, a silent alarm alerts ADT. Response by laboratory personnel is described below.

The building is accessed by laboratory employees during non-working hours by using a key and the passcode for the Building Security System.

Any breach of security during non-working hours releases a silent alarm to the security agency who alert the local law enforcement agency and one of three laboratory personnel via beeper call. Police response to security alarms takes place within 5 minutes and laboratory personnel are on-site within 20 minutes.

6. Calibration Procedures and Frequency

6.1 Introduction

Before any instrument is used as a measurement device, the instrumental response to known reference materials must be determined. The manner in which various instruments are calibrated is dependent on the particular type of instrument and its intended use. All sample measurements are made within the calibrated range of the instrument.

Instrument calibration typically consists of two types: initial calibration and continuing calibration. Initial calibration procedures establish the calibration range of the instrument and determine instrument response over that range. Typically, three to five analyte concentrations are used to establish instrument response over a concentration range. The instrument response over the range is generally absorbance, peak height, etc., which can be expressed as a linear model with a correlation coefficient (e.g. for Atomic Absorption, Inductively Coupled Plasma, UV-Visible-Infrared Spectrophotometry, Ion Chromatography) or as a response factor or amount vs. response plot (e.g. for Gas Chromatography, Gas Chromatography-Mass Spectrometry, High Performance Liquid Chromatography).

FIGURE 5-2

WESTON SAMPLE EXTRACTION FORM

SAMPLE EXTRACTION RECORD

Extract. Date:

Extraction Batch No.:

Analyst:

Sheet No.:

Test:

Cleanup Date:

Analyst:

Method:

Solvent:

Client:

Adsorbent:

Sample No.:	Client ID	pH	Initial WT/VOL	Surr. MuL 500 ul	Spike MuL 500 ul	Final VOL ACID	Final VOL BN	SpH MuL	% Solids	C/D Factor
-------------	-----------	----	----------------	---------------------	---------------------	-------------------	-----------------	---------	----------	------------

Comments:

Surrogate:

Spike:

Extracts Transferred	Relinquished By	Date Time	Received By	Date Time	Reason for Transfer

SAMPLE EXTRACTION RECORD

Figure 5-2

FIGURE 5-3

WESTON SAMPLE DIGESTION RECORD

SAMPLE DIGESTION RECORD

Sheet No: 1 of 1

Digestion Date: Digestion Batch No: Analyst: Client:
 Completion Date: Type of Prep.: Method: Matrix:
 Parameters: Type of Analysis:

Sample No:	Initial WT/VOL	Final VOL	Spike Mult.	pH <2>	% Solids	C/D FACTOR	Comments
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DIGESTION CUSTODY SHEET

Extracts Transferred:	Relinquished By	Date Time	Received By	Date Time	Reason for Transfer

SAMPLE DIGESTION RECORD

Figure 5-3

Continuing calibration usually includes measurement of the instrument response to fewer calibration standards and requires instrument response to compare with certain limits (e.g. $\pm 10\%$) of the initial measured instrument response.

The sections which follow identify specific instrument calibration procedures for various instruments.

6.2 Spectrophotometers (Colorimetric Methods)

6.2.1 Initial

Spectrophotometers will be calibrated daily before any samples are analyzed. The calibration standards will be prepared from reference materials at five concentrations which cover the anticipated range of measurements. Additionally, a calibration blank will be analyzed. The requirement for an acceptable initial calibration will be a correlation coefficient equal to or greater than 0.996. Before sample analysis, an initial calibration verification standard is analyzed. The response calculated as percent recovery of this standard must be within $\pm 15\%$ of the true value or the instrument is recalibrated.

6.2.2 Continuing

A continuing calibration standard and blank will be analyzed at a frequency of 10% and at the end of the analysis shift. The response calculated as a percent recovery of the standard must be $\pm 15\%$ of the true value. The response of the blank must be less than the detection limit.

6.3 Atomic Absorption-Inductively Coupled Plasma

6.3.1 Initial Calibration

Initial calibration of Atomic Absorption Spectrometers will include analysis of a calibration blank and a minimum of three calibration standards covering the anticipated range of measurement. The calibration curve generated must have a correlation coefficient equal to or greater than 0.996. For ICP analysis, a quarterly calibration will be performed with a blank and a minimum of five standards. The daily calibration consists of a blank and high standard. The initial calibrations will be verified using a mid-range calibration standard which is prepared from a source other than that used for initial calibration prior to analysis of samples. The requirement for verification is $\pm 10\%$ recovery of the true value. If it is outside these limits, the initial calibration is repeated.

6.3.2 Continuing Calibration

The initial calibration is verified by analysis of a continuing calibration blank and a continuing calibration verification standard after every 10 samples are analyzed. The response of the continuing calibration verification standard must be within $\pm 10\%$ recovery of the true value. The continuing calibration blank must be below the detection limit.

6.4 Cold Vapor Mercury Analyzer

6.4.1 Initial Calibration

The initial calibration procedures are as described in Section 6.3.1 except that initial calibration requires analyses of a calibration blank and five working standards. The correlation coefficient of the standard curve must be equal to or greater than 0.996. The initial calibration is verified by analysis of a calibration standard from an independent source prior to sample analysis. The response of the initial calibration verification standard must be within $\pm 20\%$ recovery of the true value. If it is outside these limits, the instrument is recalibrated.

6.4.2 Continuing Calibration

After every 10 samples, a continuing calibration blank (CCB) and continuing calibration verification standard (CCV) are analyzed. The response of the CCV must be within $\pm 20\%$ recovery of the true value. The CCB must be less than the detection limit.

6.5 Gas Chromatographs

6.5.1 Initial Calibration

Initial calibration will be performed with a calibration blank and 5 calibration standards covering the anticipated range of measurement. The correlation coefficient of this calibration must be equal to or greater than 0.996 to consider the response linear over a range. If a correlation coefficient of 0.996 cannot be achieved, additional standards must be analyzed to define the calibration curve.

6.5.2 Continuing Calibration

The response of the instrument will be verified once every 12-hour shift by analysis of a mid-range calibration standard. The calibration check standard must be within $\pm 20\%$ recovery of the initial calibration or the instrument must be recalibrated.

6.6 Gas Chromatograph-Mass Spectrometers (GC-MS)

Mass spectrometers are tuned to manufacturers' specifications with perfluorotributylamine (FC-43) on a daily basis. In addition, once per shift these instruments are tuned with decafluorotriphenylphosphine (DFTPP) or 4-bromofluorobenzene (BFB) for semivolatiles or volatiles, respectively. Once an instrument has been tuned, initial calibration curves for analytes (appropriate to the analyses to be performed) are generated for at least five solutions containing known concentrations of authentic standards of compounds of concern. The calibration curves bracket the anticipated working range of analyses.

Calibration data, to include linearity verification determined by the relative standard deviation of the response factors for the initial calibration standards (RSD <30 percent for compounds specified), will be maintained in the laboratory's permanent records of instrument calibrations.

During each operating shift, a midpoint calibration standard is analyzed to verify that the instrument responses are still within the initial calibration determinations. The calibration check compounds will be those analytes used in the USEPA Contract Laboratory Program's multicomponent analyses (e.g., priority pollutants and hazardous substances list) with the exception that benzene is used in place of vinyl chloride (volatiles) and di-n-octyl phthalate is deleted from the semi-volatile list.

The response factor drift (% D, i.e., percent difference compared to the average response factor from the initial calibration) will be calculated and recorded. If significant (> 30%) response factor drift is observed, appropriate corrective actions will be taken to restore confidence in the instrumental measurements.

7. Analytical Procedures

7.1 Laboratory Methods

Laboratory analytical methods proposed for use in this project to analyze soil and water samples are listed in Table 5 of the field QAPP. This contains, for each analytical method, a list of parameters to be determined and the limits of detection (LODs) for each parameter as currently required by USAFOEHL.

The limits of detection listed in the table are based on instrument detection limits for clean water (with no interference). Instrument detection limits are determined by following the procedures detailed in the WESTON Standard Analytical Laboratory Quality Assurance Plan (Appendix A).

WESTON's laboratory has compiled a master list of instrument detection limits covering all of the methods listed. The instrument detection limits, in most cases, are at or below the LOD's requested by OEHL. All analytical reports for this project will reference the master list of LOD's. The LOD's will be adjusted for each sample by dilution factor, percent moisture, etc.

8. Data Reduction, Validation and Reporting

8.1 Introduction

All analytical data are recorded into bound laboratory notebooks issued by the QA Coordinator. Data are recorded and associated with the unique WESTON sample identification number and the client sample identity. These pages contain the following information: analytical method, analyst, date, reagent concentrations, instrument settings (as applicable), and raw data.

The laboratory analysts sign and date all notebook entries daily. The notebook pages are reviewed periodically by the Section Manager prior to final data assembly. Copies of strip chart outputs (chromatograms, etc.) are maintained on file.

8.2 Data Reduction

Prior to submittal of a set of analyses, all calculations are completed and checked by the analyst. The associated quality control data (blanks, blank spikes, duplicates) are entered onto quality control charts and verified to be within control limits. If all data are acceptable, the data are entered into the Laboratory Information Management System and the data summaries (notebook pages, final concentrations) are submitted to the Section Manager for review. This is the procedure for all inorganic analytical data. For organic analytical data, summary reports are manually generated for review by the Section Manager. After approval, data are entered into a Personal Computer Lotus spreadsheet format). If QC samples do not meet acceptance criteria, the appropriate Section Manager and the QA coordinator are notified and corrective action is taken as described in Section 13.

Acceptable data are submitted to the Section Manager for review. After the Section Manager approves, the Data Manager is notified that data are ready to be reported and the completed analyses are removed from the laboratory backlog.

The Laboratory Data Manager generates a hard copy data summary which is reviewed and signed by the Section Manager and the Laboratory Manager.

8.3 Data Validation

In addition to the data review performed by analysts and the appropriate Section Manager, the laboratory QA Coordinator audits approximately 10% of the data reported by the WESTON Analytical Laboratory. This audit focuses on compliance of data with laboratory quality control requirements, and client contractual requirements. This audit includes selective checks on calculation, verification of the report format and completeness of the data report package.

8.4 Data Reporting

The final data report provided by WESTON Analytics conforms to one of three types:

1. Level 1 - WESTON Standard Commercial Report,
2. Level 2 - Similar to a New Jersey Tier II Report. This report provides support data including a case narrative, quality control data, and a chain- of-custody report,
3. Level 3 - U.S. EPA-CLP format report.

It is anticipated that a Level 1 or Level 2 report will be required on this project. These reports are more fully described in the following sections.

8.4.1 Standard Commercial Report- Level 1

The standard commercial report contains a transmittal letter and the following for Organic Analyses:

- o cover page describing: data qualifiers, sample collection, extraction and analysis dates, and a description of any technical problems encountered with the analysis.
- o Spreadsheet sample data and QC result summaries.
- o Five-peak library search report for GC-MS Volatiles and Semivolatiles.

QC for batches of 20 samples or less includes a method blank, a method blank spike (semivolatiles and pesticide-PCB's), a matrix spike, a laboratory duplicate, and surrogate recoveries. For sample batches of less than 10, laboratory duplicates and matrix spikes may be taken from other samples processed at the same time. Also, a method blank spike duplicate may be substituted for a matrix spike in smaller batches.

- Although the EPA CLP method is used for Level 1, WESTON Analytics deviates from the CLP required calibration criteria. Also, re-analyses will not be required for surrogate outliers unless poor recoveries are determined to be due to laboratory error.

Inorganic Analyses Level 1 reports contain a transmittal letter and the following:

- o cover page describing: data qualifiers, sample receipt, digestion and analysis dates, and a description of any technical problems encountered with the analyses.
- o sample data summary report including lab blanks.
- o QC summary report on laboratory control samples (accuracy).

8.4.2 Level 2 Report

The Level 2 report contains a transmittal letter and the following for Organic Analyses:

- o cover page
- o chain of custody-sample request form
- o case narrative and laboratory chronicle
- o tune summaries
- o sample data summaries
- o QC data including:
 - method blanks
 - surrogate recoveries
 - matrix spike-matrix spike duplicate recoveries
 - total ion chromatograms for samples

U.S. EPA CLP QC requirements will be adhered to for waters and soil-sediments.

Inorganic Analyses Level 2 reports contain a transmittal letter and the following:

- o lab chronicle
- o cover page describing: data qualifiers, sample receipt, digestion and analysis dates, and a description of any technical problems encountered with the analyses
- o sample data summary report including lab blanks
- o QC summary report on laboratory control samples (accuracy)
- o QC summary report on sample matrix spike (accuracy) and duplicate (precision analyses)
- o chain of custody-sample request form

9.0 Internal Quality Control Checks - Laboratory

The daily quality of analytical data generated in the WESTON laboratories is controlled by the implementation of WESTON's standard Analytical Laboratory Quality Assurance Plan (Appendix). As specified in the plan under "Method Performance," types and frequencies of internal quality control checks have been developed for each analysis type. In general, internal laboratory QC checks will consist of the following:

- o Method Blanks. Method blanks usually consist of laboratory reagent grade water treated in the same manner as the sample (i.e., digested, extracted, distilled, etc.) which is then analyzed and reported as a standard sample would be.
- o Method Blank Spike. A method blank spike is a sample of laboratory reagent grade water fortified (spiked) with the analytes of interest which is prepared and analyzed with the associated sample batch. Method blank spikes are not included with VOC analyses since the same function is served by the calibration standard analysis.
- o Matrix Spikes. A matrix spike is an aliquot of a field sample which is fortified (spiked) with the analytes of interest and analyzed with an associated sample batch to monitor the effects of the field sample matrix (matrix effects) on the analytical method. Matrix spikes are performed only in association with selected protocols, as specified in Appendix A. For each sample round, matrix spikes will be prepared once every 20 samples per matrix.
- o Laboratory Duplicate Samples. Duplicate samples are obtained by splitting a field sample into two separate aliquots and performing two separate analyses on the aliquots. The analysis of laboratory duplicates monitors sample precision; however, it may be affected by sample inhomogeneity, particularly in the case of nonaqueous samples. Laboratory duplicates will be run and reported for specific analyses only, as specified in Appendix. For each sample round, a laboratory duplicate will be run with every 20 field samples.

In addition to the quality control samples described above, three additional types of independent quality control checks (not associated with field sample batches) are routinely analyzed in the laboratory. These are the following:

- o Laboratory Control Sample for Inorganics. This is a standard solution with a certified concentration which is analyzed as a sample and is used to monitor analytical accuracy. (Equivalent to a method blank spike).
- o Blind Performance Sample. This is a QC sample of known concentration obtained from the U.S. EPA, the National Bureau of Standards (NBS) or a commercial source. The blind performance sample is not recognizable to the analyst as a performance sample and is used to monitor analytical accuracy.
- o Known Performance Sample. A known performance sample is the same as a blind performance sample, but is identified to the analyst so that he/she may use it to check the accuracy of an analytical procedure. It is particularly applicable when a minor revision or adjustment has been made to an analytical procedure or instrument.

9.1 QC Monitoring

The analyses of quality control samples are tabulated chronologically and entered onto a quality control chart specifically maintained for each analytical procedure. These control charts are labeled with upper and lower warning and control limits, the analysis which is being charted and the value (i.e. % recovery, RPD, etc.) which is being monitored. Control charts are updated monthly and are used to demonstrate method performance and help identify system errors.

10. Performance and System Audits

10.1 External Audits

WESTON participates in several external audits sponsored by State Regulatory Agencies and the U.S. EPA. These audits include performance and system audits.

The performance audits are in the form of blind performance samples submitted by the auditing agency. System audits involve on-site evaluation of the WESTON laboratory systems. The number, type and auditing agency for the WESTON Analytical Laboratory are summarized in Table 10-1.

10.2 Internal Audits

The laboratory QA Coordinator has overall responsibility for monitoring the internal Quality Assurance-Quality Control program. The QA Coordinator has a staff to provide in-house audits, and to review and validate analytical data packages. The QA Coordinator is also responsible for scheduling and coordinating external systems audits and reviewing data for performance samples received.

The QA Coordinator supplies blind performance samples to the laboratory at least semi-annually.

The QA Coordinator audits laboratory systems and procedures at least once annually. Unique client audit procedures and data requirements will be complied with as contractually specified. The internal audit consists of a review of laboratory systems, procedures and documentation. Any deficiencies-deviations are documented and a summary report is prepared. (See also Section 13)

TABLE 10-1

EXTERNAL PERFORMANCE AND SYSTEMS AUDITS

WESTON ANALYTICAL LABORATORIES

<u>Agency</u>	<u>Parameters</u>	<u>Type</u>	<u>Frequency</u>	<u>Purpose</u>
Illinois EPA	WS-WP	Performance System	Semi-annually	Water-Waste Water Cert. Requirement
NY Dept of Health	WS-WP	Performance	Semi-annually	Water-Waste Water Cert. Requirement
NY State Dept. Env. Conserv.	Inorganic-Organic TCL	Performance System	EPA CLP Qtrly Blinds	Required for State Analytical Contract
NJ Dept. of Environ. Prot.	WS-WP	Performance System	Annually Every 2 Yrs.	Water-Waste Water Cert. Requirement
	Haz.Waste	Performance	EPA CLP Qtrly	Haz.Waste Approval
PA Dept. of Environ. Res.	WS	Performance System	Annually Every 2 Yrs.	Water Cert. Requirement
	Haz.Waste	Performance	EPA CLP Qtrly Contract	State Anal.
U.S.EPA	Inorganic-Organic TCL	Performance System	Quarterly Every 2 Yrs.*	Superfund Related Analytical Work
U.S. Army Corps of Engineers (DERA)	Inorganic-Organic	Performance System	As Contract Requires	Water/Waste Water Superfund Analytical Work

* Last on-site by U.S.EPA was performed in May 1987
 Last PA DER on-site was performed in May 1987, and last IEPA on-site was performed in June 1987.

WS= Water Supply (Drinking Water)

WP= Water Pollution (Wastewater)

11. Preventive Maintenance

11.1 Introduction

The ability to generate valid analytical data requires that all analytical instrumentation be properly and regularly maintained. The WESTON Analytical Laboratory maintains full service contracts on all major instruments. These service contracts not only provide routine preventative maintenance but also emergency repair service. The elements of the maintenance program are discussed in the following sections.

11.2 Instrument Maintenance Log Books

Each analytical instrument is assigned an instrument log book. All maintenance activities are recorded in the instrument log. The information entered in the instrument log includes:

1. Date of service
2. Person performing service
3. Type of service performed and reason for service
4. Replacement parts installed (if appropriate)
5. Miscellaneous information

If service is performed by the manufacturer, a copy of the service record is taped into the page facing the notebook page where the above information is entered.

11.3 Instrument Calibration and Maintenance

The routine calibration procedures used for analytical instrumentation are described in Section 6 and shown in Table 11-1. Preventative maintenance and calibration by manufacturer service representatives are provided on a routine basis.

The maintenance procedures and frequencies for major analytical instrumentation are given in Table 11-2.

As described in Section 11-1, WESTON service agreements provide for preventative maintenance, emergency service and emergency shipping of spare parts. For emergency response, service contracts on the Gas Chromatographs, GC/MS instruments and AA-ICP require on-site response within 48-72 hours. (Typically, service representatives are on site within 24 hours of a service call.) The service contracts also provide for 24-hour delivery of critical spare parts in response to a service request.

11.4 Spare Parts

WESTON Laboratory maintains an inventory of routinely required spare parts (for example, spare sources, vacuum pumps and filaments for GC/MS, spare torches, burner heads for AA-ICP).

The instrument operators have the responsibility, with the appropriate Section Manager, to ensure that an acceptable inventory of spare parts is maintained.

TABLE 11-1

CALIBRATION FREQUENCY AND MECHANISM FOR MAJOR INSTRUMENTS

WESTON ANALYTICAL LABORATORY

<u>Instrument</u>	<u>Frequency of Calibration</u>	<u>Standard</u>	<u>Indicator Parameters</u>
GC/MS	Daily (or every 12 hrs)	Standard soln of analytes to be measured	Response- Sensitivity
GC (Hall, PID, EC, NPD, FID, FPD)	Daily (or more frequently as required)	Standard soln of analytes to be measured	Retention Time Response- Sensitivity
HPLC	Daily	Standard soln of analytes to be measured	Retention Time Response Sensitivity
AA	Daily (or more fre- quently)	Standard soln of analytes to be measured	Response Linear Range
ICP	Daily (or more fre- quently)	Standard soln of analytes to be measured	Response Linear Range
Ion Chromatograph Daily		Standard soln of Analytes to be Measured	Retention Time Response
Spectrophoto- meters	Daily	Standard soln of Analytes to be measured	Response Linear Range
Technicon Auto- Analyzer	Daily	Standard soln of Analytes to be measured	Response Linear Range
Conductivity Meter	Daily	Standard soln of Analytes to be measured	Response
Analytical Balance	Daily, when used	Class S weights (NBS Cert)	Accuracy
Ovens	Quarterly	NBS Thermo- meter	Accuracy

TABLE 11-2

INSTRUMENT MAINTENANCE SCHEDULE

WESTON ANALYTICAL LABORATORY

<u>Instrument</u>	<u>Preventative Maintenance</u>	<u>Service Contract</u>
Gas Chromatograph-Mass Spectrometer	Semi-annually	Yes
Gas Chromatographs	Semi-annually	Yes*
GC Detectors (FID, EC, PID, Hall, NPD, FPD)	As needed	Yes*
High Performance Liquid Chromatographs	As needed	No
Atomic Absorption Spectrometer (Flame and Furnace)	Semi-annually	Yes
Inductively Coupled Plasma Spectrometer	Semi-annually	Yes
Analytical Balance	Annually	Yes
Ion Chromatograph	Annually	Yes
Spectrophotometers	As needed	No
Cold Vapor Mercury AA	As needed	No
Technicon Autoanalyzer	As needed	
Conductivity Meter	As needed	No
Ovens	As needed	No
pH-Specific Ion Meter	As needed	No

* All but one gas chromatograph have service contracts.

12. Procedure Used to Assess Data Quality

12.1 Introduction

The QA objectives for precision, accuracy and completeness were given and discussed in Section 3, and this section will discuss the routine procedures used for assessment of those criteria.

12.2 Precision

The precision of analyses of replicate samples is calculated as given in Section 3. The precision requirements for Organic Analyses are given in Table 3-2. All analytical data are reviewed relative to those criteria.

For metal and inorganic analyses, the QA objective for precision is $\pm 20\%$ relative percent difference (RPD) between replicate analyses.

12.3 Accuracy

The calculation of analytical accuracy for organic compounds is as given in Section 3, and the criteria for assessing the accuracy for surrogate recovery are those given in Table 3-1. Corrective action for surrogate recoveries outside of those criteria will require sample re-analysis when more than one surrogate per fraction (ie volatile fraction, base neutral fraction and acid fraction) is outside specified criteria.

The criteria for analytical accuracy of metal analyses are those given in Section 3. For other inorganic analysis, the objective for accuracy (as % recovery for a laboratory control standard) is $\pm 20\%$. Any accuracy data which are outside of the control limits as described in Section 10 will require appropriate corrective action.

12.4 Completeness

Completeness has been defined in Section 3 as a measure of the amount of analytical data of acceptable quality (i.e., data meeting all accuracy and precision criteria) generated by an analytical method or system. The minimum goal for completeness is 85% and the ability to exceed this goal (especially for organic TCL analyses) is dependent on the applicability of the analytical methods to the sample matrices analyzed.

13. Corrective Action

The initial responsibility to monitor the quality of an analytical system lies with the analyst. In this pursuit, the analyst will verify that all quality control procedures are followed and results of analysis of quality control samples are within acceptance criteria. This requires that the analyst assess the correctness of all of the following items as appropriate:

- Sample Preparation Procedure
- Initial Calibration
- Calibration Verification
- Method Blank Result
- Duplicate Analysis
- Laboratory Control Standard
- Fortified Sample Result

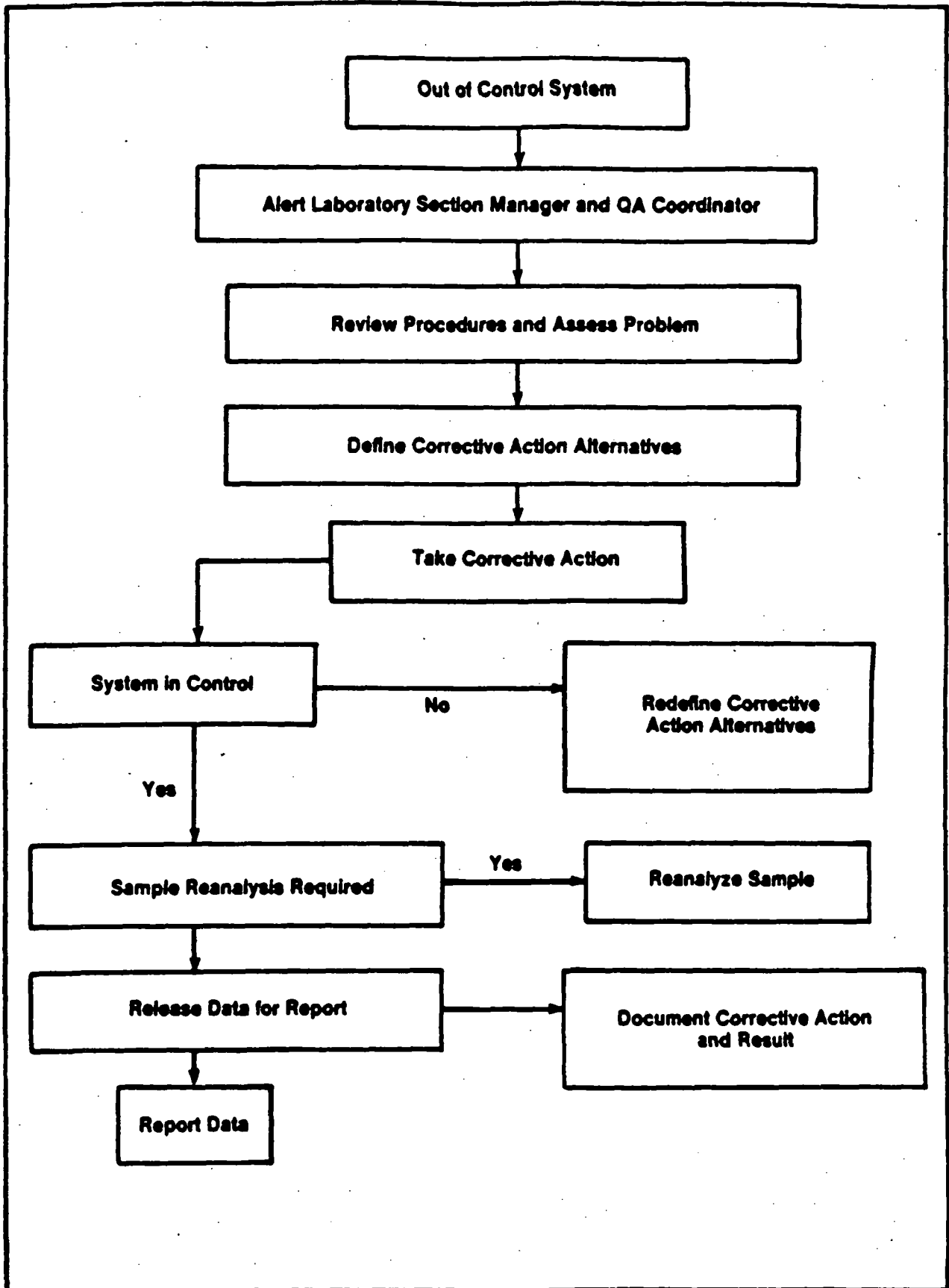
If the assessment reveals that any of the QC acceptance criteria are not met, he must immediately assess the analytical system to correct the problem. He notifies the Section Manager and QA Coordinator of the problem and if possible identifies potential causes and corrective action.

The nature of the corrective action obviously depends on the nature of the problem. For example, if a continuing calibration verification is determined to be out of control, the corrective action may require recalibration of the analytical system and re-analysis of all samples since the last acceptable continuing calibration standard.

When the appropriate corrective action measures have been defined and the analytical system is determined to be "in control", the analyst documents the problem, and the corrective action. Copies of the form summarizing these actions are provided to the Section Manager and QA Coordinator (See Figure 13-2).

Data generated concurrently with an out-of-control system will be evaluated for usability in light of the nature of the deficiency. If the deficiency does not impair the usability of the results, data will be reported and the deficiency noted in the case narrative. Where sample results are impaired, the Laboratory Project Manager is notified and appropriate corrective action (eg. reanalysis) is taken.

The critical path for assessing the correctness and acceptability of analytical data is shown in Figure 13-1.



**CRITICAL PATH FOR CORRECTIVE ACTION
 WESTON ANALYTICAL LABORATORIES**

CORRECTIVE ACTION DOCUMENTATION

AUDIT REPORT # _____

PAGE _____ OF _____

DATE/ORIGINATOR: _____

PERSON RESPONSIBLE FOR RESPONSE: _____

DISTRIBUTION:

- ☐ EARL HANSEN
- ☐ DEB WHITE
- ☐ CARTER NULTON
- ☐ J. MICHAEL TAYLOR
- ☐ DIANNE THERRY
- ☐ MONTHLY REPORT FILE

DESCRIPTION OF PROBLEM and when identified: _____

State cause of problem if known or suspected: _____

SEQUENCE OF CORRECTIVE ACTION: (If no responsible person is identified, bring this form directly to the QA Coordinator)

State date, person, and action planned: _____

CA Initially Approved By: _____ Date: _____

Follow-up dates: _____

Description of follow-up: _____

Final CA Approved By: _____ Date: _____

14. Quality Assurance Reports to Management

The QA Coordinator provides quarterly and annual reports to the WESTON corporate QA Coordinator. These reports summarize QA activities for the reporting period including results of performance audits (external and internal), results of system audits (external and internal), summaries of corrective action to remedy out of control situations and recommendation for revision in laboratory procedures to improve the analytical systems. The Project Manager will be notified immediately of laboratory QA situations requiring immediate corrective action.

APPENDIX A

Analytical Laboratory Quality Assurance Plan



STANDARD PRACTICES MANUAL

OPERATING PRACTICE

Eff Date 12/01/87 Initiated By DLST Reviewed By RJR Authorized By *[Signature]* APT SP No. 21-20-018

ANALYTICAL LABORATORY QUALITY ASSURANCE PLAN

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7.0 SUBCONTRACTED ANALYSES

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1.0 PURPOSE

The purpose and goal of laboratory quality assurance/quality control (QA/QC) is to ensure that all data generated in the laboratory conform to specific requirements for accuracy, precision, and completeness. This quality assurance/quality control plan describes the organization and procedures routinely incorporated into all analyses performed by the WESTON laboratory for the purpose of producing reliable data.

2.0 DISCUSSION

Customized, client-specific quality control measures (to include project-specific quality assurance/quality control plans) can be added to or can supercede these basic guidelines to satisfy the special needs of individual programs. Laboratory personnel are available to discuss the design, advantages, and disadvantages of other quality control options.

This plan has been prepared in accordance with "Guidelines and Specifications for Preparing Quality Assurance Program Plans," QAMS-004/80, 20 September 1985.

3.0 ORGANIZATION

3.1 Laboratory Manager

The ultimate responsibility for the generation of reliable laboratory data rests with the Laboratory Manager. The Laboratory Manager is vested with the authority to effect those policies and procedures to ensure that only data of the highest attainable caliber are produced.

3.2 Section Managers

To assist the Laboratory Manager in achieving his goals, the Organic Section Manager, Inorganic Section Manager, and Support Section Manager, as well as the laboratory Quality Assurance/Quality Control Coordinator and analytical project managers, are responsible for the implementation of the established policies and procedures. They possess the authorities commensurate with their responsibilities for the day-to-day enforcement and monitoring of laboratory activities.

Section Managers have the responsibility for ensuring that their personnel are adequately trained to perform analyses, that equipment and instrumentation under their control are calibrated and functioning properly, and that system audits are performed on a periodic basis. These system audits will include the analysis of external check



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samples to determine the analyst/instrument capability to identify and quantify routine analytes.

3.3 Quality Assurance/Quality Control Coordinator

The Quality Assurance/Quality Control Coordinator has the responsibility for the conduct of and evaluation of results from system audits. In addition, the preparation of standard operating procedures and quality assurance documentation for the laboratory is a function of the Quality Assurance/Quality Control Coordinator. The Quality Assurance/Quality Control Coordinator will review program plans for consistency with organizational and contractual requirements and will advise appropriate personnel of inconsistencies.

3.4 Laboratory Personnel

Any effective quality assurance and quality control program depends not only on organization and management but also on the efforts of each and every individual on the laboratory staff. The initial review for acceptability of analytical results rests with the analysts conducting the various tests. Observations made during the performance of an analytical method may indicate that the analytical system is not in control. Analysts must be constantly aware for indications of perturbations from the norm and be ready to verify that the system is in control before continuing analyses or reporting results of analyses.

4.0 SAMPLE MANAGEMENT

An organized and efficient sample management system is a necessary and critical foundation on which actual analyses of samples are based. Sample management includes client file creation, bottle preparation, sample preservation, sample receipt, sample storage, chain-of-custody documentation, reporting and invoicing, and sample retention and disposal.

4.1 Client File

On notification of a sampling and analysis effort, the laboratory will create a client file to maintain records associated with the project. In addition to administrative information (work order and plan numbers, client contacts, etc.), requests for sample containers, preservatives, and required analyses will be included in the file. As the project progresses, chain-of-custody and analytical results as well as any other pertinent information will be added to the file.

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4.2 Bottle Preparation and Sample Preservation

On request by the Project Manager, sample bottles will be prepared by the laboratory and made available to the sampling team. The bottles will be prepared according to WESTON standard operating procedures and will include sample preservatives appropriate to the analytes and matrices of concern. Addition of preservatives to samples shall be recorded in field notebooks and on chain-of-custody forms. WESTON adheres to the most recent recommendations from the U.S. Environmental Protection Agency (EPA) for proper sample containers and preservatives.

If sample bottles are not supplied by the laboratory, the client assumes responsibility for bottle selection and preparation.

4.3 Chain-of-Custody

Chain-of-custody procedures document the history of samples and constitute a crucial part of sampling and analysis programs. Chain-of-custody documentation assists and enables the identification and tracing of a sample from the time of collection through the time of analysis.

When sample bottles are supplied by the laboratory, chain-of-custody forms will accompany the containers to the field. As samples are collected, entries are made on the chain-of-custody forms. Data to be noted include:

- Date
- Samples
- Sample description
- Client/program
- Container and preservative
- Analyses required
- Special instructions/notes

Sample containers are also labelled with:

- Date
- Sample description
- Preservatives
- Analyses required
- Client/program

When samples are received at the laboratory, the sample custodian will verify each and every sample against the chain-of-custody forms, note any discrepancies or losses of samples, and then sign for receipt of



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the samples. Samples will remain under the control of the sample custodian until samples are transferred to the analysts for processing. Analysts will acknowledge receipt of samples by signing the chain-of-custody forms.

A sample is considered to be in custody if it:

- Is in the physical possession of the responsible party.
- Is in view of the responsible party.
- Is secured by the responsible party to prevent tampering.
- Is secured by the responsible party in a restricted area.

4.4 Sample Receipt

Samples received at the laboratory are inspected for integrity, and any field documentation is reviewed for accuracy and completeness. If chain-of-custody forms do not accompany the samples, the sample custodian will initiate these forms. When samples are received with missing or deficient chain-of-custody forms, the legal traceability of these samples cannot extend to the time of collection but must begin at the time of laboratory receipt.

Chain-of-custody and sample integrity problems are noted and recorded during sample log-in. The Project Manager is informed of the deficiencies and will advise the laboratory on the desired disposition of the samples. Chain-of-custody forms and deficiency notices are maintained in the client file.

Each sample that is received by the laboratory is assigned a unique sequential WESTON sample number which will identify the sample in the laboratory's internal tracking system.

References to a sample in any communication will include the assigned sample number to specify which sample is of concern.

4.5 Sample Storage

Samples will be stored in a locked refrigerator at 4°C. The temperature of the storage refrigerators will be monitored and recorded daily by the sample custodian. Sample fractions and extracts will also be stored under these same conditions.

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4.6 Sample Retention and Disposal

Samples will be retained in the refrigerator for thirty (30) calendar days after the date of the invoice accompanying the analytical results. Unless a written request is received for retaining the sample beyond the thirty (30) days, the samples will be disposed of in an appropriate manner.

5.0 ANALYTICAL SYSTEMS

5.1 Instrument Maintenance

Instruments will be maintained in accordance with manufacturers' specifications. More frequent maintenance may be dictated dependent on operational performance. Instrument logs will be maintained to document the date and type of maintenance performed.

Contracts on major instruments with manufacturers and service agencies are used to provide routine preventive maintenance and to ensure rapid response for emergency repair service. Minimal instrument down-time is experienced through the use of these contracts.

5.2 Instrument Calibration

Before any instrument can be used as a measurement device, the instrumental response to known reference materials must be determined. The manner in which the various instruments are calibrated will be dependent on the particular instrument and the intended use of the instrument. All sample measurements will be made within the calibrated range of the instrument. Preparation of all reference materials used for calibration will be documented in a standards preparation notebook.

Laboratory balances will be calibrated annually and will be checked before and after use on a daily basis. A record of calibrations and daily checks will be kept in the balance log.

Oven thermometers will be calibrated annually against a National Bureau of Standards certified thermometer in the range of interest. Annual calibrations will be recorded in a calibration notebook. Daily readings will be recorded with the respective analysis (e.g., the solids book).

5.3 Personnel Training

Prior to conducting analyses on an independent basis, analysts are trained by experienced personnel in the complete performance of an

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analytical method. If instrumentation is particularly complicated, analysts may be trained at instrument manufacturers' training courses. The analyst is then required to independently generate data on several method and/or matrix spikes to demonstrate proficiency in that analytical method. The type of data to be generated will be dependent on the analytical method to be performed. Results of this "certification" are then reviewed by the appropriate supervisor for adequacy.

Since method blanks and method spikes are required routine samples in every lot, performance on a day-to-day basis can be monitored by comparison with the original and cumulative data on similar samples. Supervisors and the laboratory Quality Assurance/Quality Control Coordinator are responsible for ensuring that samples are analyzed by only competent analysts.

5.4 Standard Analytical Methods

General: Analytical methods are routinely conducted as outlined in published sources (EPA, Standard Methods, ASTM, AOAC, etc.). Modifications to these methods may be necessary in order to provide accurate analyses of particularly complex matrices. When modifications to standard analytical methods are performed, the specific alterations as well as the reason for the change will be reported with the results of analyses.

5.4.1 Gas Chromatography/Mass Spectroscopy (GC/MS)

5.4.1.1 GC/MS Instrument Performance Documentation

Mass spectrometers are tuned on a daily basis to manufacturer's specifications with FC-43. In addition, once per shift, these instruments are tuned with decafluorotriphenylphosphine (DFTPP) or 4-bromo-fluorobenzene (BFB) for semi-volatiles or volatiles, respectively. Ion abundances will be within the windows dictated by the specific program requirements. Once an instrument has been tuned, initial calibration curves for analytes (appropriate to the analyses to be performed) are generated for at least five (5) solutions containing known concentrations of authentic standards of compounds of concern. The calibration curve will bracket the anticipated working range of analyses.

Calibration data, to include linearity verification determined by response factor evaluation (RSD <30 percent for compounds named in ensuing section 5.4.1.2 of this operating practice) will be maintained in the laboratory's permanent records of instrument calibrations.

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5.4.1.2 GC/MS Method Performance Documentation

During each operating shift, a midpoint calibration standard is analyzed to verify that the instrument responses are still within the initial calibration determinations. The calibration check compounds will be those analytes used in the EPA Contract Laboratory Program's multicomponent analyses (e.g., priority pollutants and hazardous substances list) with the exception that benzene is used in place of vinyl chloride (volatiles) and di-n-octyl phthalate is deleted from the semi-volatile list.

The response factor drift (% D, i.e., percent difference compared to the average response factor from the initial calibration) will be calculated and recorded. If significant (>30%) response factor drift is observed, appropriate corrective actions will be taken to restore confidence in the instrumental measurements.

All GC/MS analyses will include analysis of a method blank, a method blank spike (semi-volatiles and pesticides/PCB's), a matrix spike, and a laboratory duplicate in each lot of twenty (20) or fewer samples. The US EPA-CLP matrix spike solutions will be used for both matrix spikes and blank spikes. In addition, appropriate surrogate compounds specified in EPA methods will be spiked into each sample. Recoveries from method spikes and surrogate compounds are calculated and recorded on control charts to maintain a history of system performance.

A method blank spike duplicate sample may be analyzed in place of the matrix spike for analytical lots of less than ten (10) samples.

Audit samples will be analyzed periodically to compare and verify laboratory performance against standards prepared by outside sources.

5.4.1.3 GC/MS Detection Limits

The US EPA-CLP contract required quantitation limits (CRQL) are used for reporting GC/MS data. These detection limits are compared with laboratory-determined instrument detection limits to ensure that the reported values are attainable. Instrument detection limits are determined from triplicate analysis of target compounds measured at three to five times the CRQL. The calculated instrument detection limit is three times the standard deviation of the measured values.

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5.4.2 Gas Chromatography and High Performance Liquid Chromatography (GC and HPLC)

5.4.2.1 GC and HPLC Calibration

Gas chromatographs and high performance liquid chromatographs will be calibrated prior to each day of use. Calibration standard mixtures will be prepared from appropriate reference materials and will contain analytes appropriate for the method of analysis.

Working calibration standards will be prepared fresh daily. The working standards will include a blank and a minimum of five (5) concentrations to cover the anticipated range of measurement. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations (or response) must be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be obtained, additional standards must be analyzed to define the calibration curve. A midpoint calibration check standard will be analyzed each shift to confirm the validity of the initial calibration curve. The check standard must be within twenty (20) percent of the initial response curve to demonstrate that the initial calibration curve is still valid. For multi-analyte methods, this check standard may contain a representative number of target analytes rather than the full list of target compounds.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

5.4.2.2 GC and HPLC Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limits.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

The method spikes will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery of the spikes. These recoveries will be plotted on control charts to monitor method accuracy. Precision will be measured by the reproducibility of both method spikes and will be calculated as relative percent

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difference (% RPD). These % RPD's will be plotted on control charts to monitor method precision.

5.4.2.3 GC and HPLC Detection Limits

The US EPA-CLP contract required quantitation limits (CRQL) are used for reporting GC pesticide data. These detection limits are compared with laboratory determined instrument detection limits to ensure that the reported values are attainable. Instrument detection limits are determined from triplicate analysis of target compounds measured at three to five times the CRQL. The calculated instrument detection limit is three times the standard deviation of the measured values. For non-CLP compounds, the reported detection limits will be limited by the lowest calibration standard analyzed for the respective method.

The reported detection limits for HPLC analyses are limited to the concentration of the lowest calibration standard analyzed on a particular day. The only exception to this for HPLC analyses are analyses conducted according to USATHAMA analytical and Quality Assurance Protocols. In those cases, detection limits are reported in accordance with procedures described in "USATHAMA Quality Assurance Plan," December 1985, 2nd Edition, March 1987 (U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, MD 21010-5401).

5.4.3 Atomic Absorption Spectrophotometry (AA)

5.4.3.1 AA Calibration

Atomic absorption spectrophotometers will be calibrated prior to each day of use.

Calibration standards will be prepared from appropriate reference materials, and working calibration standards will be prepared fresh daily. The working standards will include a blank and a minimum of three (3) concentrations to cover the anticipated range of measurement.

Duplicate injections will be made for each concentration. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to analysis of samples.

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Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

5.4.3.2 AA Quality Control

At least one method blank and two method blank spikes (laboratory control samples: LCS) will be included in each laboratory lot of samples. Regardless of the matrix being processed, the LCS and blanks will be in aqueous media. The LCS will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory and will be introduced at a frequency of one per analytical lot or five (5) percent of the samples, whichever is more. The LCS will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be within the range 80-120 percent to be considered acceptable, with the exception of antimony and silver, due to documented method deficiencies in achieving reliable recovery (reference EPA's Contract Laboratory Program). Additionally, the LCS % R will be plotted on control charts to monitor method performance.

Precision will be measured by the reproducibility of both LCS and will be calculated as relative percent difference (% RPD). Results must agree within twenty (20) percent RPD in order to be considered acceptable.

5.4.3.3 AA Detection Limits

The laboratory routinely reports EPA-CLP Contract Required Quantitation Limits (CRQL's) for client reports. These limits are compared with laboratory-determined Instrument Detection Limits (IDL's) on a quarterly basis to ensure that the reported values are attainable. IDL's are determined from three nonconsecutive day's analysis of seven consecutive measurements of target compounds at three to five times the IDL. Each day's seven measured values are averaged and the respective standard deviation calculated. Three times the standard deviation of the average of the standard deviations obtained from the three days' analysis is defined as the IDL. The IDL's must be at or below the CRQL's.



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5.4.4 Inductively Coupled Plasma Spectroscopy (ICP)

5.4.4.1 ICP Calibration

The inductively coupled plasma spectrometer will be calibrated prior to each day of use. Calibration standards will be prepared from reliable reference materials and will contain all metals for which analyses are being conducted. Working calibration standards will be prepared fresh daily. Quarterly, calibration will be performed with a blank and a minimum of five (5) concentrations to cover the anticipated range of measurement. Duplicate readings will be made for each concentration. At least one of the calibration standards will be at or below the desired instrumental detection limit. The correlation coefficient of the plot of responses versus concentrations will be at least 0.996 in order to consider the responses linear. If a correlation coefficient of 0.996 cannot be obtained, the spectrometer will be recalibrated prior to analysis of samples. This calibration will be done quarterly to verify the linear range of the instrument.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

On a daily basis, the instrument will be calibrated using a standard at the high end of the calibration range and a blank. The calibration is verified with a mid-range calibration check standard which is prepared from a different source than the instrument calibration standard. This standard must not deviate more than ± 10 percent from the target value. In addition, a linear range check at approximately two times the detection limit will be analyzed to verify linearity near the detection limit.

5.4.4.2 ICP Quality Control

At least one method blank and two method blank spikes (laboratory control samples: LCS) will be included in each laboratory lot of samples. Regardless of the matrix being processed, the LCS's and blanks will be in aqueous media. The LCS will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

The LCS results will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery ($\% R$) of the spikes. The recovery must be within the range 80-120 percent to

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be considered acceptable. Additionally, the LCS & R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both LCS and will be calculated as relative percent difference (% PRD). Results must agree within twenty (20) percent RPD in order to be considered acceptable.

5.4.4.3 ICP Detection Limits

The laboratory routinely reports EPA-CLP Contract Required Quantitation Limits (CRQL's) for client reports. These limits are compared with laboratory-determined Instrument Detection Limits (IDL's) on a quarterly basis to ensure that the reported values are attainable. IDL's are determined from three nonconsecutive day's analysis of seven consecutive measurements of target compounds at three to five times the IDL. Each day's seven measured values are averaged and the respective standard deviation calculated. Three times the standard deviation of the average of the standard deviations obtained from the three days' analysis is defined as the IDL. The IDL's must be at or below the CRQL's.

5.4.5 Total Organic Carbon (TOC)

5.4.5.1 TOC Calibration

The total organic carbon analyzer will be calibrated prior to each day of use.

Calibration standards will be prepared from potassium hydrogen phthalate, and working calibration standards will be prepared fresh daily. The working standards will include a blank and a minimum of five (5) concentrations to cover the anticipated range of measurement.

At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to analysis of samples. Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.



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5.4.5.2 TOC Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory. The method spikes will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be within the range 80-120 percent to be considered acceptable. In addition, % R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both method spikes and will be calculated as relative percent difference (% RPD). Results must agree within twenty (20) percent RPD in order to be considered acceptable.

2.4.5.3 TOC Detection Limits

The detection limits are based on the concentration of the lowest standard analyzed. Results below the lowest standard are reported as below the detection limit.

5.4.6 Ion Chromatography (IC)

5.4.6.1 IC Calibration

The ion chromatograph will be calibrated prior to each day of use. Calibration standards will be prepared from appropriate reference materials, and working calibration standards for the ions of interest will be prepared fresh daily. The working standards will include a blank and a minimum of five (5) concentrations to cover the anticipated range of measurements. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to analysis of samples.

Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

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5.4.6.2 IC Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

The method spikes will be examined to determine both precision and accuracy. Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be within the range of 80-120 percent to be considered acceptable. Additionally, % R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both method spikes and will be calculated as relative percent difference (% RPD). Results must agree within twenty (20) percent RPD in order to be considered acceptable.

5.4.6.3 Ion Chromatography Detection Limits

The detection limits are based on the concentration of the lowest standard analyzed. Results below the lowest standard are reported as below the detection limit.

5.4.7 Spectrophotometric (Colorimetric) Methods

5.4.7.1 Spectrophotometer Calibration

Spectrophotometers will be calibrated prior to each day of use. Calibration standards will be prepared from reference materials appropriate to the analyses being performed, and working calibration standards will be prepared fresh daily. The working standards will include a blank and minimum of five (5) concentrations to cover the anticipated range of measurement. At least one of the calibration standards will be at or below the desired instrument detection limit. The correlation coefficient of the plot of known versus found concentrations will be at least 0.996 in order to consider the responses linear over a range. If a correlation coefficient of 0.996 cannot be achieved, the instrument will be recalibrated prior to the analysis of samples.



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Calibration data, to include the correlation coefficient, will be entered into laboratory notebooks to maintain a permanent record of instrument calibrations.

5.4.7.2 Spectrophotometer Quality Control

At least one method blank and two method spikes will be included in each laboratory lot of samples. Regardless of the matrix being processed, the method spikes and blanks will be in aqueous media. Method spikes will be at a concentration of approximately five (5) times the detection limit.

The method blanks will be examined to determine if contamination is being introduced in the laboratory.

The method spikes will be examined to determine both precision and accuracy.

Accuracy will be measured by the percent recovery (% R) of the spikes. The recovery must be in the range (80-120 percent) in order to be considered acceptable. Additionally, % R will be plotted on control charts to monitor method accuracy.

Precision will be measured by the reproducibility of both method spikes and will be calculated as relative percent difference (% RPD). Results must agree within twenty (20) percent RPD in order to be considered acceptable.

5.4.7.3 Spectrophotometric Methods Detection Limits

The detection limits are based on the concentration of the lowest standard analyzed. Results below the lowest standard are reported as below the detection limit.

5.5 Methods Development

When standard (published) methods of analyses are not applicable to analyses to be performed, methods can be developed to provide the desired information. However, the lack of a historical data base does not obviate the necessity for documented quality control data to demonstrate the validity of the generated results. Reference material sources must be identified, and proof of compound identity and purity must be available. Instrumental operating parameters as well as calibration data must be documented, and specific procedures (to include sampling, if applicable) must be noted. Quality control samples (method blanks, method spikes, method spike duplicates, matrix spikes, and matrix duplicates) should be analyzed with greater

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frequency than with standard analytical methods to demonstrate the certainty and uncertainty of generated data. Exact requirements for demonstrating the reliability of developed methods are normally dictated by the specific program.

5.6 Reference Materials

Whenever possible, primary reference materials will be obtained from the National Bureau of Standards (NBS) or the U.S. Environmental Protection Agency (EPA). In the absence of available reference materials from these organizations, other reliable sources will be sought. These reference materials will be used for instrument calibration, quality control spikes, and/or performance evaluations. Secondary reference materials may be used for these functions provided that they are traceable to an NBS standard or have been compared to an NBS standard within the laboratory.

5.7 Reagents

Laboratory reagents will be of a quality to minimize or eliminate background concentrations of the analyte to be measured. Reagents must also not contain other contaminants that will interfere with the analyte of concern.

5.8 Corrective Actions

An analysis or analytical system is considered to be out-of-control when it does not conform to the conditions specified by the method or standard operating procedures which apply. To confirm that an analysis or analytical system is in control, the laboratory routinely performs instrument calibration checks, analysis of method blanks and method blank spikes and compares the results of quality control samples to laboratory control charts or analytical protocol criteria (e.g., U.S. EPA-CLP).

When an analysis or analytical system is determined to be out-of-control, the person who identifies that there is a problem is responsible for documenting the occurrence and notifying his or her supervisor and/or Section Manager.

A Corrective Action Documentation Form (Figure 1) is to be completed for each out-of-control situation. It will be distributed to the Section Manager, QA Coordinator and Project Manager. The analyst, working with his or her supervisor or Section Manager, will attempt to determine the cause of the problem and take appropriate corrective action. Analysis may not resume until the problem has been corrected and it is determined that the analysis is back in control.

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Demonstration of the restoration of analytical control will normally be accomplished by generating satisfactory calibration and/or quality control sample data. This documentation will be attached to the corrective action documentation form.

Data generated concurrently with an out-of-control system will be evaluated for usability in light of the nature of the deficiency. If the deficiency does not impair the usability of the results (e.g., blank contaminated but all samples not detected), data will be reported and the deficiency noted in the case narrative. Where sample results are impaired, the Project Manager is notified and appropriate corrective action (e.g., reanalysis) is taken.

6.0 DATA MANAGEMENT

6.1 Data Collection

In addition to the data collected in the field and recorded on the chain-of-custody forms, data describing the processing of samples will be accumulated in the laboratory and recorded in laboratory notebooks. Laboratory notebooks will contain:

- Date of processing
- Sample numbers
- Client (optional)
- Analyses or operation performed
- Calibration data
- Quality control samples included
- Concentrations/dilutions required
- Instrument readings
- Special observations (optional)
- Analysts signature

6.2 Data Reduction

Data reduction is performed by the individual analysts and consists of calculating concentrations in samples from the raw data obtained from the measuring instruments. The complexity of the data reduction will be dependent on the specific analytical method and the number of discrete operations (extractions, dilutions, and concentrations) involved in obtaining a sample that can be measured.

For those methods utilizing a calibration curve, sample responses will be applied to the linear regression line to obtain an initial raw result which is then factored into equations to obtain the estimate of the concentration in the original sample. Rounding will not be performed until after the final result is obtained to minimize



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rounding errors, and results will not normally be expressed in more than two (2) significant figures.

Copies of all raw data and the calculations used to generate the final results will be retained on file to allow reconstruction of the data reduction process at a later date.

6.3 Data Review

System reviews are performed at all levels. The individual analyst constantly reviews the quality of data through calibration checks, quality control sample results, and performance evaluation samples. These reviews are performed prior to submission to the Section Managers or the Analytical Project Manager.

The Section Manager and/or the Analytical Project Manager review data for consistency and reasonableness with other generated data and determine if program requirements have been satisfied. Selected hard copy output of data (chromatograms, spectra, etc.) will be reviewed to ensure that results are interpreted correctly. Unusual or unexpected results will be reviewed, and a resolution will be made as to whether the analysis should be repeated. In addition, the Analytical Project Manager or Section Manager will recalculate selected results to verify the calculation procedure.

The Quality Assurance Officer independently conducts a complete review of selected projects to determine if laboratory and client quality assurance/quality control requirements have been met. Discrepancies will be reported to the appropriate Section Manager and/or Analytical Project Manager for resolution.

The final routine review is performed by the Laboratory Manager prior to reporting the results to the client. Non-routine audits are performed by regulatory agencies and client representatives. The level of detail and the areas of concern during these reviews are dependent on the specific program requirements.

6.4 Data Reporting

Reports will contain final results (uncorrected for blanks and recoveries), methods of analysis, levels of detection, surrogate recovery data, and method blanks data. In addition, special analytical problems, and/or any modifications of referenced methods will be noted. The number of significant figures reported will be consistent with the limits of uncertainty inherent in the analytical method. Consequently, most analytical results will be reported to no more than two (2) significant figures. Data are normally reported in



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units commonly used for the analyses performed. Concentrations in liquids are expressed in terms of weight per unit volume (e.g., milligrams per liter). Concentrations in solid or semi-solid matrices are expressed in terms of weight per unit weight of sample (e.g., micrograms per gram).

Reported detection limits will be the concentration in the original matrix corresponding to the low level instrument calibration standard after concentration, dilution, and/or extraction factors are accounted for.

6.5 Data Archiving

The laboratory will maintain on file all of the raw data, laboratory notebooks, and other documentation pertinent to the work on a given project. This file will be maintained for five (5) years from the date of invoice unless a written request is received for an extended retention time.

Data retrieval from archives will be handled in a similar fashion to a request for analysis. Specifically, a written work request to include a quotation must be submitted for retrieval of data.

Client confidentiality will be maintained with retrieved data. Consequently, the laboratory can honor only those requests for data authorized by the original client.

7.0 SUBCONTRACTED ANALYSES

The subcontracting of analytical services does not relieve the laboratory of requirements set forth in this plan. Adherence to the provisions of this plan will be part of the subcontracting agreement, and data generated by the subcontractor laboratory will be reviewed with the same rigor as those analyses performed at WESTON facilities.

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Figure 1

Corrective Action Documentation Form

CORRECTIVE ACTION DOCUMENTATION		AUDIT REPORT # _____
DATE/ORIGINATOR: _____	PERSON RESPONSIBLE FOR RESPONSE: _____	PAGE _____ OF _____
		DISTRIBUTION:
		<input type="checkbox"/> EARL HANSEN
		<input type="checkbox"/> DEB WHITE
		<input type="checkbox"/> CARTER MULTON
		<input type="checkbox"/> J. MICHAEL TAYLOR
		<input type="checkbox"/> DIANNE TERRY
		<input type="checkbox"/> MONTHLY REPORT FILE
DESCRIPTION OF PROBLEM and when identified: _____		

State cause of problem if known or suspected: _____		

SEQUENCE OF CORRECTIVE ACTION: (If no responsible person is identified, bring this form directly to the QA Coordinator)		
State date, person, and action planned: _____		

CA Initially Approved By: _____ Date: _____		
Follow-up dates: _____		
Description of follow-up: _____		

Final CA Approved By: _____ Date: _____		

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ATTACHMENT 2

**STANDARD OPERATING PROCEDURES
FOR THE COLLECTION OF
ENVIRONMENTAL SAMPLES**

**STANDARD OPERATING PROCEDURES
FOR THE
COLLECTION OF ENVIRONMENTAL
SAMPLES**

March 1986

Prepared By:

**Environmental Resources Management, Inc.
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Revised: _____

The ERM Group

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SECTION 1

INTRODUCTION

This document is Environmental Resources Management, Inc.'s (ERM) Standard Operating Procedures (SOPs) for the Collection of Environmental Samples, and includes procedures for collecting ground water, surface water, soil, sediment samples, and air samples. This document is intended to be an integral part of ERM's Quality Assurance/Quality Control project plans which also includes the following support documents: (1) the Site-Specific Project Work Plan, (2) Subcontract Laboratory Quality Control Plan, (3) Subcontract Laboratory Operations Manual, and (4) the Project Health and Safety Plan.

As much as possible, the procedures in this document have been standardized to make them applicable to all types of environmental investigations. It must be recognized, however, that under certain site specific conditions, all of the procedures discussed herein may not be appropriate. In such cases, it will be necessary to adapt the procedures given to the specific conditions of the investigation. To guarantee the timeliness of ERM's Standard Operating Procedures, every six months this document will be reviewed and updated as necessary. Dates of review will be listed on the front cover and amendment on each individual page. All ERM employees are invited to comment on these Standard Operating Procedures and to submit their comments in writing to the company Quality Assurance Coordinator.

This document is divided into four major sections: (1) preparation of a project sampling plan; (2) procedures for the collection of environmental samples; (3) post-sampling procedures; and (4) sample packaging, shipping, chain-of-custody.

SECTION 2**PREPARATION OF A PROJECT SAMPLING PLAN**

Prior to the collection of environmental samples, it is necessary to prepare a project sampling plan which is site-specific. This will require determination of the following: (1) the objectives of the sampling program, (2) the media to be sampled, (3) the sampling locations, and (4) the analyses to be conducted. Predetermination of these items will result in the design and performance of a cost-effective and technically feasible sampling plan.

The three basic objectives of a sampling plan are the following: (1) determine the presence or absence of contamination, (2) determine the extent and magnitude of contamination, and (3) determine the contaminant pathways which may exist at a site. Each of these will greatly affect the sampling plan as each will subsequently affect the determination of the media to be sampled, the sampling locations, and the analyses to be conducted.

The second step in developing a sampling plan is the determination of the media to be sampled at a particular site. This may include the collection of surface and ground water samples, stream sediment samples, leachate springs or seeps, soil or rock samples, or air samples. Again, the materials to be sampled will be greatly affected by the objectives of the sampling.

The third step is to determine the sampling locations. In addition, it is necessary that the justifications for the selection of the sampling locations be detailed along with the intended use of the data.

The fourth step is to determine exactly what analysis will be conducted. The constituents analyzed are usually selected for several reasons. These are: (1) required by regulations; (2) considered to be toxic and present at the site or there is an indication of their presence at the site; (3) indicators of contamination which may not be toxic; and (4) site-specific constituents or those constituents known to be present at the site whether toxic or non-toxic.

All of the above factors will be dependent upon the work to be conducted at the site, whether it be a site investigation, feasibility study, and/or remedial design. In order to make informed decisions as to the above considerations, it is mandatory that all available background data on the site be collected

and reviewed. Using this information, a detailed site-specific sampling plan for the investigation can be proposed. The plan must include a checklist of all equipment which will be needed during the sampling and a detailed discussion of all procedures to be used. As stated previously, the following sections will detail ERM's Standard Operating Procedures for the collection of environmental samples. These are to be used where applicable in the development and performance of the sampling plan.

SECTION 3

PROCEDURES FOR THE COLLECTION OF ENVIRONMENTAL SAMPLES

The following discussion of sampling procedures for the collection of environmental samples is divided into five sections. These sections include procedures for the collection of (1) ground water, (2) surface water, (3) sediment, (4) soil samples, and (5) air samples.

3.1 Ground Water Sampling

There are two types of wells from which ground water samples may be obtained; monitoring wells or residential wells and municipal wells. Sampling from each of these will require the collection of different types of presampling information and sampling equipment, as well as different sampling procedures. Since sampling from monitoring wells is by far the most complex, it will be addressed first. The sampling of monitoring wells is further divided into three subsections: (1) preparation for sampling, (2) well evacuation, and (3) sample collection.

3.1.1 Monitoring Wells

3.1.1.1 Preparation for Sampling

Prior to going to a site, it is important to know the specifics of well construction, including: inside diameter of the well casing, total depth of the well, depth to the screened portion of the well, screen length, and the material used in the construction of the well and well screen. The diameter of the well casing is most important as it will directly affect the equipment and procedures to be used during well evacuation and sampling. The majority of the wells used only for monitoring have two-inch inside diameter casings, however, some older wells may have inside diameters of less than two inches. In many cases where ground water recovery may be a viable option for remediation of a contamination problem, wells with either four-, six-, or eight-inch inside diameter casings may have been installed. It is also important to know the accessibility of the wells. This may affect the selection of the sampling equipment to be used or, at a minimum, the procedure for getting the equipment to the well location. Prior to sampling, locate all the wells on a site map

and determine the order in which each well will be sampled. If the water quality information is available, the order of well samples should be from least contaminated to most contaminated. Direction of anticipated or known ground water flow can be used to determine sampling order where no chemical data are available. Wells upgradient of the source area should be sampled first, then proceed from wells farthest downgradient and work towards the source area.

The following is a list of equipment which may be needed when evacuating and sampling monitoring wells:

- Material for sample preparation (see Section 4.2).
- Reagents for sample preservation (see Section 4.3).
- Appropriate sample containers (see Section 4.4).
- Meters, probes, and standards for field measurements (see Section 4.5).
- Appropriate field and transportation blanks. The type and number of blanks should be established with the laboratory conducting the analysis.
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Keys. Many monitoring wells will have locking caps and keys will be necessary to gain access. In addition, some sites may be secured or may have a guard on duty, in which case keys and/or permission may be necessary.
- Tools to assist in well access. These may include screw drivers, hammers, chisels, pipe wrenches, or possibly a propane torch. All or any of these may be necessary for removing steel security caps on wells which have not been recently opened.
- Tape measure graduated in tenths and hundredths of feet. A tape measure may be useful for measuring the diameter of the well casing and the elevation of the well casing above ground level.
- Electronic water level indicator/graduated depth sounder. These may be necessary for determining the static water level and the total depth of the well if it is unknown.

- Pocket calculator. This may be used for determining the volume of water within the well which, in turn, will be used for calculating the volume of water to be evacuated.
- Log book and indelible ink marker. This is for recording information pertinent to the sampling procedures used and observations on the environmental conditions at the time of sampling.
- Well evacuation equipment. In general a pump will be used to purge or evacuate stagnant water in the well prior to obtaining the sample (per Section 3.1.1.2). The size and capacity of the pump to be used will depend upon the inside diameter of the well casing, the depth to water, total depth of the well, well yield, and the volume of water to be removed. In some cases it may be necessary to use a bailer for well evacuation. ERM recommends that the following equipment be used for well evacuation when applicable.
 - For two-inch diameter wells where the depth to water is greater than 25 feet; an Isco Model No. 2600 diaphragm-type pump should be used for well evacuation.
 - For any well with an inside diameter of 2 inches or greater and where the water level in the well will remain above 25 feet; a self-priming centrifugal pump should be used. A gate valve may be necessary to adjust the pumping rate so that the level of water in the well can be maintained above 25 feet. The ease of decontamination for this equipment makes it the first choice for evacuation.
 - A small-diameter bailer may be used to evacuate two-inch wells with a low volume of water needed to be purged from the well.
 - For large-diameter wells (4 inches or greater) where the depth to water is below 25 feet, a large-diameter, impeller-type, submersible pump will be required for evacuation. Great caution

must be taken when using this pump as it can be very difficult to decontaminate compared to the other pumps used for evacuation.

- A dry inert gas or compressed air regulator. This is needed to activate the Isco 2600 pump. Nitrogen gas is recommended. Argon gas or compressed air can be used as an alternative.
- Bottom loading PVC, stainless steel, or Teflon bailer. The bailer will be used to obtain the ground water sample after the well has been evacuated. The choice of the material in bailer construction will depend on the site-specific characteristics.
- Decontamination solutions/water. These will be used for decontaminating all equipment that comes into contact with the ground water or contaminated materials (see Section 5.1).
- Buckets, scrub brushes, and sponges will be needed during cleaning of all contaminated material (see Section 4.1).
- Buckets and/or graduated plastic pails. These will be used for measuring the flow rate and volume of water evacuated from the well prior to sampling and also for containment of potentially contaminated water until it can be properly disposed of if required by the investigation. A low-flow, totalizing meter can be used where necessary.
- Camera/film. These may be required for documenting sampling procedures and well locations.

After assembling all of the required sampling equipment, be sure that it is in working order, and has been decontaminated.

3.1.1.2 Well Evacuation

Prior to evacuating the well, it will be necessary to determine the volume of water being held in the well casing. The calculation of the well volume should be conducted as follows:

1. Measure well casing inside diameter.

2. Determine the static water level. This should be measured to the nearest one-hundredth of a foot below the measuring point elevation. The top of the well casing should be used as the measuring point and marked to standardize its location. (Note: The water indicator must be cleaned before use in each well.)
3. Determine the total depth of the well from the measuring point.
4. Calculate the number of linear feet of static water (total depth of the well minus the static water level).
5. Calculate the static volume in gallons ($\pi r^2 h \times 7.48 \text{ gal/ft}^3$).

where:

$\pi = 3.14$

r = radius of well in feet

h = number of linear feet of static water

It is ERM's policy that three well volumes be removed prior to sample collection. In most cases, removal of three well volumes should insure the collection of a representative sample not influenced by stagnant water remaining in the well casing, and yet not result in overpumping of the well. The latter can result in pulling diluted or more concentrated ground water from another area within the aquifer. If the well goes dry, during evacuation allow it to recover and re-evacuate until at least one and one-half (1-1/2) volumes are purged.

Before evacuating the well, the depth at which to place the pump in the well must be determined. In high-yielding wells the pump should be placed near the top of the water column rather than in the screened area. This forces water to move up the well casing to the pump; otherwise, water may be removed from the formation only and water standing in the well above the screen may not be evacuated. This will not occur though if the pumping rate is high enough to cause significant well drawdown. Most diaphragm-type pumps for small-diameter wells are not capable of flows greater than one and one-half (1-1/2) gallons per minute. Therefore, this problem is greater in high-yielding, small-diameter wells. If well yield is low to moderate, the pumps should be placed at the bottom of the screened interval. The flow rate of the pumps may be measured using a graduated plastic bucket, or a totalizing flow meter in the case of submersible pumps.

The sample must not be obtained from the pump or bailer used to purge the well. Furthermore, any hose coming in contact with the ground water must be decontaminated before use in the next well to avoid the possibility of cross-contamination. Cross-contamination can be avoided if the rope and the hose used during well evacuation is dedicated to each particular well and decontaminated between each use in that particular well. If this is not feasible, the rope and hose should be decontaminated between use in each well at the site.

3.1.1.3 Sample Acquisition

The following procedure is recommended for obtaining ground water samples from monitoring wells:

- If a pump has been used to purge the well, the hose, rope, and pump must be removed from the well and decontaminated and/or stored in an appropriately labeled container if each is to be dedicated to the particular well. The pump used for evacuation must be dismantled and cleaned, if necessary.
- If a bailer has been used to purge the well, a previously cleaned second bailer must be used to obtain the sample.
- The bailer used for collecting the sample should be lowered into the well, retrieved, and emptied to insure that the bailer is only in contact with water in the well.
- When collecting the ground water needed for filling the sample bottles, the bailer should be gently lowered sufficiently into the water column to collect or sample unaffected by equilibration with the atmosphere (approximately ten feet, if possible), jerked gently to insure the ball valve is closed, and retrieved at a steady rate to the surface.
- When transferring the water from the bailer to the sample containers, care must be taken to avoid agitation to the sample which will promote the loss of volatile constituents, and promote chemical oxidation.

- If a bailer is not dedicated to a specific well, it must be cleaned between wells. Procedures for cleaning of equipment are given in Section 4.1. Again, all equipment and materials coming into contact with the inside casing of the wells or the ground water must be cleaned.

The geochemistry of ground water is such that exposure of ground water samples to atmospheric conditions can result in substantial loss of sample integrity. Therefore, it is necessary that immediately after collection, the samples are prepared, preserved, and stored in such a manner as to prevent any changes in sample chemistry. Refer to subsequent sections of this document for the procedures for sample preparation, preservation, storage, and in situ measurements.

3.1.2 Residential and Municipal Wells

Some precautions must be taken when collecting ground water samples from residential and municipal wells. Proper scheduling of sampling periods for residential and municipal wells is important. It is important that a municipal well be sampled while it is in a pumping cycle; thus insuring that you are taking a sample from water that has not been held stagnant in the well casing. Residential wells are continuously pumped, with the usage rate varying over the course of the day (heavy in the early morning hours for showers, etc.; moderate during the day; and heavy again at evening during cooking, dishwashing, and shower usage). This continuous usage creates an established homogeneity in the water entering the residential well. Therefore, the largest factor affecting sample integrity is the residence time water has spent in the pressure tank (holding tank). Also, when sampling a group of residential wells in a particular area, be sure to sample them over a relatively short period of time. When collecting more than one round of samples, make the sampling periods consistent with respect to the time of day the samples are taken.

When sampling residential and municipal wells, site accessibility is normally not a problem, since a limited amount of equipment is required. However, accessibility of the well can cause major problems. Before attempting to sample a residential well, determine if the well is physically accessible for sampling. For municipal wells, check to see if a spigot or valve is available from which a sample can be taken. Be sure that the sampling port or spigot is positioned as close to the well head as possible and prior to any type of treatment process, such as a water softener or carbon filtration unit. Residential wells generally have a spigot located at the base of the pressure tank. This is usually

the closest tap to the actual well head. When collecting raw samples from the tap off the pressure tank, a cold water faucet should be turned on and run a minimum of five minutes and/or until temperature stabilization (two readings plus/minus ten percent). pH and/or conductivity may also be used to indicate fresh water is entering the pressure tank. After stabilization has been achieved, continue to run the cold water faucet and collect samples from the tap off the pressure tank. This will insure collection of a representative sample.

Contact the owner's or operator's of the wells to determine what tools, valves, hoses, etc., will be needed. Wrenches may be needed for opening and closing faucets or spigots. Often spigots on municipal wells may be too large, resulting in a high-volume flow which will make sampling difficult. In this case, it will be necessary to reduce the flow by using appropriate fittings. Obtain information from the operator on the size of the fittings required and on accessibility of the sampling spigot. It may be convenient to attach a section of hose to the line, especially under very cramped quarters.

Generally, all the equipment listed in the previous section on ground water sampling for monitoring wells should be used during the sampling of residential and municipal wells with the exception of the pumps and the bailer. Since municipal wells are high-volume water producers, there is no necessity for evacuating the well. However, the lines between the well and the spigot must be cleared. For most residential and municipal wells, the samples can be collected either directly into the sample bottles or, in cases where sample filtration is needed, samples can be placed directly into the filtration apparatus.

When collecting samples after residential or municipal systems with activated carbon treatment, a post-treatment tap simply needs to be cleared of stagnant water. Sample collection can then proceed, usually directly into the sample container. As with the ground water samples collected from monitoring wells, it will be necessary to prepare and preserve the samples prior to storage. Refer to the later sections of this document for the procedures for sample preparation, sample preservation, and sample storage in Sections 4.2, 4.3, and 4.4, respectively.

3.2 Surface Water Sampling

Surface water sampling may include the sampling of streams, rivers, ponds, or lakes. Prior to sampling, the surface water drainage in and around the area to be studied should be characterized using all available background information, including

topographic maps and aerial photographs. As with all sampling procedures, an initial survey of the site should be conducted to verify sampling locations. This site survey will help to identify any special equipment, personnel safety requirements, or procedures which might be necessitated by terrain or other factors specific to the site. Needed background information includes: the depth of the surface water body, flow rate, and overall position of the sampling point and/or stream or tributary in the stream basin. Also, it is recommended that stream characteristics, such as stagnation zones or mixing zones which might affect the distribution or volatilization of constituents in the water, be noted.

The equipment needed for most surface water sampling is minimal. In fact, in many instances, the sample container will serve as the sampling device. The following is a recommended list of surface water sampling equipment and accessories:

- Materials for sample preparation (see Section 4.2).
- Reagents for sample preservation (see Section 4.3).
- Appropriate sample containers (see Section 4.4).
- Meters, probes, and standards for in situ measurements (see Section 4.5).
- Appropriate field and transportation blanks. The type and number of blanks should be established with the laboratory conducting the analysis.
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Flow and velocity estimation devices.
- Sampling devices. These may include anything from use of the sample containers to use of a telescoping aluminum pole with an attached clamp and beaker known as a grab sampler. These can be bought from laboratory supply houses. Otherwise, a Kemmerer sampler can be used to collect samples from a particular depth in the water column. Due to problems which may result from the inaccessible nature of many surface sampling locations, it may be appropriate to use a boat to sample surface waters.

- Decontamination solutions/water. These will be used for decontaminating all equipment that comes into contact with the sample (see Section 4.1).
- Buckets, plastic wash basins, scrub brushes, and sponges. These will be used for cleaning contaminated equipment and materials.
- Camera/film. For use in documenting sampling procedure and sample location.

Most surface water samples are taken as grab samples. Typically, surface water sampling involves immersing the sample container into the body of water. The following suggestions are made to help insure that the samples obtained are representative of the body of water being sampled:

- Generally, the most representative samples of streams or rivers are obtained at mid-channel, at one-half of the stream depth in a well mixed stream.
- Stagnated areas in streams or rivers might contain zones of contaminant concentration, depending upon the physical/chemical properties of the contaminants and the position of these stagnated waters relative to the source of contamination.
- When sampling a stream, proceed from downstream to upstream stations to avoid releasing contaminants into the water from bottom sediments.
- Though the containers used to obtain the samples are previously cleaned in the laboratory, it is recommended that the sample container be rinsed at least once, preferably three times, with the water to be sampled before the sample is taken.
- Sampling must begin at the suspected zones of lowest contamination and proceed towards to the zones of highest contamination.
- When sampling a pond or other large standing body of water, the surface area may be divided into grids. A series of samples may be taken from each grid and combined into one sample (a composite) or separate samples may be obtained from several grid locations at random. This will improve the representativeness of the sample and/or samples.

- A discrete composite sampler may be used to collect a composite sample at a specific location over time or proportional to flow.
- Care should be taken to avoid excessive agitation of the water which can result in the loss of volatile constituents.
- Do not take a surface water sample at the surface/water interface unless sampling specifically for a known constituent which is immiscible with water (i.e., such as oil which floats on top of water). Instead, the sample container should be inverted, lowered to one-half the water depth, and held at about a 45° angle with the mouth of the bottle facing upstream.

Generally, surface water samples are more stable than ground water samples because these waters tend to be in equilibrium with atmospheric conditions. Therefore, samples from these streams will not undergo significant changes in water chemistry upon extraction from their environment. However, it is best not to assume that the surface water samples can be left unattended after collection. Hence, it is necessary to prepare, preserve, and store the samples appropriately as described in Sections 4.2, 4.3, and 4.4 of this document. Also, it is important that all the in-situ measurements described in Section 4.5 of this document be performed immediately after sample collection.

3.3 Sediment Sampling

The collection of sediment samples from ponds, lagoons, or streams is normally not a difficult task unless sampling is being conducted at great depth, in which case a boat and specialized equipment would be necessary. Caution must be taken to obtain samples which will be representative of the contaminants of interest versus the sediment materials present. For example, it is unlikely that absorbed organic constituents will be found in high concentrations in coarse-sized materials. However, the finer materials which are most likely to absorb organic contaminants from stream waters may not be located within the immediate flow areas of the stream transporting the contaminants, rather they would be located in less turbulent areas.

A review of site background information may give an indication of the type of constituents present in the sediments and the type of sediments to be collected. It is important to consider the following:

- Constituents which may have affinities for particular sediment types.
- Hydrogeological information which may help establish a relationship between the contaminant source and the contaminants in the sediment.
- The pH of the surface water over the sediments. Unusual pH conditions may influence contaminant precipitation.
- Several sediment samples should be obtained from the area nearest the suspected contaminant point source. These samples should also be collected from various types of materials near the source (i.e., coarse gravels versus fine clays) to determine the relationship of the contaminants to the sediment material.
- Samples should be collected progressing from downstream to upstream to prevent the release of potentially contaminated sediments from one sampling station to another further downstream.

When developing a sampling plan for the collection of sediments from small streams or surface drainageways, it is important to address possible effects of runoff which may have occurred many years prior to the time of sampling. Consequently, it is often insufficient to test only the surface sediments because erosion and deposition of additional stream bed sediments in the intervening years could have formed a cover of uncontaminated surface sediments over potentially contaminated sediments. Therefore, the following procedures are recommended for the collection of samples from small streams:

- Assess which side of the stream received contaminated sediments from overland flow and collect samples on that side of the stream from mid-stream to the stream bank.
- Using a shovel, core or bucket sampler, collect a surface grab or composite sample of the top six inches of sediment.

- At these same locations, collect another grab or composite sample at an approximate depth of six to twelve inches.
- The number of samples collected at each location should be proportionate to the stream width (i.e., three samples from a six-foot wide stream should sufficiently characterize sediment quality).

Comparatively, when sampling from large rivers, ponds or lakes, it may be necessary to lay out a visual or surveyed grid, if possible, and composite samples or collect grab samples from either random or regular locations within the grid.

After determining the relationship between the contaminant constituents and the sediments, a sampling plan can be prepared. The following is a list of recommended sediment sampling equipment:

- Materials for sample preparation (see Section 4.2).
- Appropriate sample containers (see Section 4.4).
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Log book and indelible ink marker. This is for recording information pertinent to the sampling procedures used and observations on the environmental conditions at the time of sampling.
- Sampling devices. Sample devices may range from the sample container and a trowel, to more elaborate power-driven devices. See the discussion below on sediment sampling techniques.
- Decontamination solutions/water. These will be used for decontaminating all equipment that comes into contact with the sediment and the sampling devices (see Section 4.1).
- Buckets, wash basins, scrub brushes, and sponges. These will be used for cleaning of all contaminated materials.
- Camera/film. For use in documenting sampling procedures and sample locations.

Very simple techniques can usually be employed in collecting sediment samples. Below are some suggested techniques for sediment sampling:

- As previously mentioned, in small, low-flowing streams or near the shore of a pond or lake, the sample container, a shovel, or hand-operated bucket auger may be used to scrape up sediments. The sediment must be dewatered as much as possible so as not to reflect soluble concentrations in the water.
- To obtain sediments from larger streams or further from the shore of a pond or lake, a beaker attached to a telescoping aluminum pole by means of a clamp may be used to dredge sediments.
- To obtain sediments from rivers or in deeper lakes and ponds, a spring-loaded sediment dredge (Eckman dredge) or benthic sampler may be used. Several types of sediment core samples exist for specialized sampling of sediments.

Lastly, all the equipment used should be decontaminated between the sampling stations using the procedures described in the following section.

3.4 Soil Sampling

There are two types of soil samples: surface (consisting of the top two feet) and subsurface (below two feet). In most cases, both types will be collected as grab samples. Although, in some cases composite sampling may be useful for obtaining data about contamination over a wide area. This provides a rough estimate of the overall extent and magnitude of contamination, while reducing the analytical costs. However, when composite sampling, it is important that extreme care be taken in documenting the location and depth of the composites.

3.4.1 Surface Soil

Listed below are three possible scenarios for the collection of surface soil samples over a large area:

- the total area may be divided by a grid system to identify specific sampling locations;

- if the area is large and if complete characterization is required, a random sampling approach may be used to reduce the number of samples. In this instance, the area is laid out in a grid and sample locations determined randomly; and
- an extremely large study area can also be divided by grids with soil samples being composited from several locations within the grid.

The list of equipment necessary for the collection of surface soil samples may be minimal, depending upon the analytical parameters to be determined. As previously discussed in Section 2 of this document, the sampling devices may be constructed of either PVC, linear polyethylene, Teflon, or stainless steel, depending upon the parameters of interest. The following is a list of equipment necessary for the collection of surface soil samples:

- Materials for sample preparation (see Section 4.1).
- Appropriate sample containers (see Section 4.4).
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Log book and indelible ink marker. This is for recording information pertinent to the sampling procedures used and information on environmental conditions at the time of sampling.
- Sampling devices. Generally, these include a scoop or hand trowel constructed of appropriate material. However, in some cases, shovels, picks, hoes, and/or hand augers may be necessary.
- Decontamination solutions/water. These will be used for decontaminating equipment (see Section 4.1).
- Buckets, plastic wash basins, scrub brushes, and sponges. These will be used in the cleaning of contaminated equipment.
- Camera/film. For use in documenting sampling procedures and sample location.

Grab samples of surface soils are collected by placing the scooped or troweled sample into an appropriately sized bottle. However, composite soil sampling requires considerably more caution. Depending upon the number of samples to be collected and the area to be covered, the soil samples from various areas should be placed into an appropriately constructed pan, thoroughly mixed, and an appropriately sized aliquot taken. It is important that the volume of soil from each location be as identical as possible. When possible, it is recommended that composite soil sampling only be conducted when the soils are relatively dry. Wet soils are very difficult to work with thus making the collection of a representative composite sample difficult. Since it is necessary to split the samples and expose them to the atmosphere prior to storage, it is impossible to collect representative composite soil sample for volatile constituents.

3.4.2 Subsurface Soil

Subsurface soils can be collected either as grab or composite samples. The same precautions for composite sampling of surface soils apply to the compositing of subsurface soils. Although this document does not generally discuss safety factors involved in the collection of samples, it is important at this point to note that the collection of subsurface soil samples can constitute a substantial safety hazard. The most important safety factor involved is the avoidance of buried containers or pockets of highly contaminated material. A thorough background information search should be completed before obtaining subsurface samples. At a minimum, a metal detector survey should also be performed at sites where buried materials are suspected.

Generally, the problems encountered in the collection of subsurface soil samples are similar to those encountered in the collection of surface soil samples. Additionally, subsurface sampling must also address the depths from which the samples will be obtained. The overall approach is similar to that discussed previously for surface sampling, considering the aspects of grid systems and random versus specific sampling locations. The depths at which samples are to be taken will depend upon the suspected contaminants, their general mobilities, and the method by which they have entered the subsurface environment. Generally, subsurface samples can be obtained by three methods: shallow subsurface sampling by hand-operated equipment and deep subsurface samples by use of a drilling rig or a backhoe.

The following is a list of recommended equipment for sampling subsurface soils:

- Materials for sample preparation (see Section 4.2).
- Appropriate sample containers (see Section 4.4).
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Log book and indelible ink marker. This is for recording information pertinent to the sampling procedures used and observations on the environmental conditions at the time of sampling and the location.
- Sampling devices (depending upon the sampling methods described in the following paragraph).
- Decontamination solutions/water. These will be used for decontaminating all equipment that comes into contact with the soils and the inside of the casing or auger flights (see Section 4.1).
- Buckets, wash basins, scrub brushes, and sponges. These will be used for equipment decontamination.
- Steam cleaner. A steam cleaner should be used when attempting to decontaminate large pieces of equipment such as auger flights.
- Camera/film. These are for use in documenting sampling procedures and sample locations.

Depending upon the depth and type of samples to be collected, a variety of methods are available for sampling subsurface soils. These include:

- A shovel which may be used to depths of several inches or several feet, depending on soil types.
- A slotted sampling trier which is limited to about two and one-half (2-1/2) to three feet.
- A hand auger may be used to collect subsurface samples at depths up to four to five feet; however, it mixes and thus destroys the cohesive structure and stratigraphic character of the soil preventing detailed soil description.

- A hand-driven split-spoon sampler provides a means to obtain somewhat undisturbed core samples. The depth will again be limited by the soil type.
- Drill rig-operated sampling devices. These may be placed into two categories: (1) solid stem augers and (2) hollow stem augers. With solid stem augers, materials are mixed as brought to the surface, making representative samples from discreet depths impossible to obtain. With hollow stem augers, either a split-spoon or Shelby tube can be used for sample collection.
- Soil samples may be collected from a backhoe trench. It is emphasized that at no time should the sampler enter the backhoe trench. A contaminated air supply or possible caving makes this a dangerous situation. To collect samples from the pit, a long-handled bucket auger or the backhoe bucket may be used to collect the soil from the desired depth interval.

Lastly, proper decontamination procedures, discussed in Section 4.1, should be used in cleaning all the soil sampling equipment. Sample preservation for soils is not as imperative although volatile organic soils should be kept cool, and ERM recommends refrigeration of all soil samples.

3.5 Air Sampling

Air sampling of a hazardous waste site is useful in assessing potential adverse health effects caused by the inhalation of organics or inorganic constituents. Organic compounds volatilizing into the air from surface streams, lagoons, open drums, or contaminated soils, as well as inorganic particulates, such as asbestos or lead, may be collected in sampling bags or tubes and analyzed to determine the specific constituents and their respective concentrations.

As previously discussed with the other types of environmental sampling, an initial survey of the site is necessary to provide background information needed for the design of an effective air sampling program. This background information includes: identification of personnel safety requirements, the locations of potential contaminant source areas, location of a background sampling station, and prevailing upwind and downwind directions. Also, if the types of constituents that are being monitored are known, then the sampling program should be designed to better

detect these constituents. For example, heavy organic compounds will migrate along the ground surface and should be sampled at ground level.

The equipment needed for air sampling is minimal. Sampling for organic constituents will only be addressed in this section. Sampling air for organic vapor is performed by drawing air into a sample collection bag using an Analytical Instrument Development, Inc. Portable Organic Vapor Meter (OVM). Two design features of the Model 580 make this type of sample collection the preferred method. The first is that the detection system used in the Model 580 is the Photoionization Detector which is a non-destructive detector, making it possible to run the sample through the detector into the sample bag without changing the character of the sample. This makes it possible for the collection of the exact sample which may cause a high reading on the meter. The feature of the Model 580 that allows this sample collection is a positive displacement pumping system used to draw the sample into the Model 580. It is then a very simple procedure to attach the sample bag to the exit of this pump and trap the sample after it has passed through the detector.

Besides the OVM, the other necessary equipment needed for air sampling is as follows:

- Sample Collection Bag. The material and size of the sample bag is dependent upon the constituents which are to be analyzed. A one-liter size is an acceptable sample volume for most analysis. When analyzing for organic compounds, absorption of the organic molecules onto the surface of the bag becomes a serious problem. It is suggested that the bags be constructed or at least lined with Teflon or polyethylene to minimize the amount of absorption.
- Intake Collection Tube. This may be constructed of a relatively inert material, such as Tygon, which can be disposed of after the collection of each sample.
- Chain-of-custody labels, tags, and record forms (see Section 5.2).
- Log book and indelible ink marker. This is for recording information pertinent to the sampling.
- Camera/film. For use in documenting sampling procedures and sample locations.

The actual collection of the sample is a relatively easy operation. The bag is attached to the OVM using the intake tubing. The OVM is switched on and air is pumped through the OVM, out the exit port, and into the sample bag until the bag is stiff but not bursting. The OVM Model 580 pumps at a rate of 500 ml per minute which will fill a one-liter bag in approximately two minutes. During filling, the OVM readings should be recorded for comparison to the final analysis. After the bag is filled, the valve on the bag is closed, and the bag is detached from the intake tubing.

It should be noted that air samples cannot be collected as composite samples since the bag may not be sealed and opened again before analysis. Also, analysis of the constituents in the bag should be conducted as soon as possible to prevent possible absorption of organics onto the surface of the bag. Background information on site conditions can be obtained by collecting an upwind sample at the site. During the sampling period, recording of the general weather conditions such as wind directions, wind speed, temperature, humidity, and degree of cloud cover may prove useful in the assessment of the results. Because high humidity and/or dampness interfere with the OVM intake system, air samples may not be collected during precipitation events.

Other than sample labeling, logging, and chain-of-custody, there is very little preparation needed for air samples. Organic samples should be kept cool (about 4°C) as prescribed in Section 4.3 of this document. The intake tubing should be discarded after each sample is collected. Most collection bags are reusable and should be properly purged according to the specifications of each individual manufacturer.

SECTION 4**POST-SAMPLING PROCEDURES**

Post sampling procedures include: (1) equipment decontamination, (2) sample preparation, (3) sample preservation, and (4) sample storage. Additionally, in many cases, in-field measurements of certain parameters may be required.

4.1 Equipment Decontamination

All non-disposable equipment used for the collection, preparation, preservation, and storage of the environmental samples must be cleaned prior to their use and after each subsequent use. Unless the equipment and materials being used are disposable or of sufficient number so as not to be reused during any one sampling period, decontamination will have to be conducted in the field. Field decontamination can be a tedious and expensive chore, as it can require taking into the field a sizable amount of equipment and reagents. If possible, attempts should be made to minimize field decontamination.

The materials needed for decontamination are dependent upon the equipment to be cleaned. The following is a very generalized list of equipment to be used during decontamination:

- Cleaning solutions. These will be dependent upon the items to be cleaned and the parameters which are being analyzed.
- Water. In some cases, tap water may be adequate for initial or intermediate rinses. The final rinses, however, must be with deionized/distilled water.
- Storage vessels. These will be used to transport large volumes of deionized/distilled water to the site. It is recommended that fifteen-gallon plastic carboys with a spigot positioned near the bottom of the tank be used.
- Buckets and wash basins. For use in the washing and rinsing of equipment.

- A drying rack. All materials and equipment must be dried prior to additional use. Paper towels or Chemwipes should not be used for drying surfaces of equipment which come into contact with the samples.
- Paper towels and Chemwipes. For use in cleaning all outside surfaces or surfaces that do not come into contact with the sample.

Basically, there are two types of recommended field cleaning procedures. When collecting samples for inorganic constituents, the following procedures are recommended:

- Wash with a non-phosphate detergent (or steam clean).
- Rinse with tap water.
- Wash or rinse through the use of a squirt bottle with a dilute nitric acid. A one to five percent nitric acid solution is adequate.
- Rinse three times with deionized/distilled water.

When sampling for organic parameters, the following cleaning sequence is recommended:

- Wash with a non-phosphate detergent (or steam clean).
- Rinse with tap water.
- Rinse with reagent-grade acetone.
- Triple rinse with deionized water.

If analyses are to be conducted for ammonia or nitrogen compounds, it is necessary that a one to five percent solution of hydrochloric acid be used in place of the nitric acid bath. If it is found that persistent stains or water marks are present, it may be desirable to use a chromic acid solution as a further cleaning procedure. However, both hydrochloric acid and chromic acid are extremely corrosive and, if possible, their use should be avoided while in the field.

Larger pieces of equipment may require specialized decontamination procedures. The small-diameter bladder-type pump can be decontaminated with the use of two specially-designed decontamination tanks. These tanks can be constructed of a three-foot section of four-inch I.D. PVC pipe with an end cap placed on one end. The pump is set inside one tank along with three to five gallons of clean tap water. By pumping the clean tap water from

the tanks, both the outside and inside of the pump can be decontaminated. After the tap water wash, the pump should be appropriately cleaned as per the above procedures using deionized water and the second tank.

The tubing used for a centrifugal pump can be decontaminated by pumping tap and then distilled water through the tubing. The outside of the tubing can be decontaminated by use of a pressure sprayer. To avoid cross-contamination, it is recommended that the PVC tubing be dedicated to each well and cleaned between uses.

Larger diameter submersible pumps are difficult to decontaminate and for this reason should be used only where absolutely necessary. These pumps have high flow rates and large volumes of clean water are needed to decontaminate the inside of the tubing. In most cases, the cost of the tubing for these pumps is prohibitive to dedication of tubing to each well. A pressure sprayer can be used to effectively decontaminate the outside of the pump and tubing. At sites where a clean tap water source is available, the submersible pump should also be decontaminated by pumping 75 to 100 gallons through it and the discharge tubing. A 45-gallon polyethylene drum has been dedicated for this use.

4.2 Sample Preparation

Immediately before sample collection, each sample bottle should have a label attached which includes the following information: sample identification, date, time, sampler's name, analysis requested, and the site name.

Whether or not a sample is to be prepared prior to preservation and storage depends upon the analyses to be conducted and the type of sample collected. If dissolved metal concentrations are desired, then the sample must be filtered in the field immediately after collection. Field filtration of surface water samples is not as critical as filtration of ground water samples. Surface water samples generally exist in equilibrium with atmospheric conditions and, as such, will not undergo rapid change after collection. However, ground waters tend to be more reducing and, precipitation will occur if the sample is not filtered immediately after withdrawal.

It is recommended that all surface and ground water samples be filtered using a Sartorius™, or Nalgene™ filtration apparatus or a Millipore™ pressure filter, depending on the quantity and turbidity of the samples (Figures 1, 2, and 3). The Sartorius™ and Nalgene™ apparatus is inert with respect to metals and also

Figure 1
Sartorius Filtration Apparatus

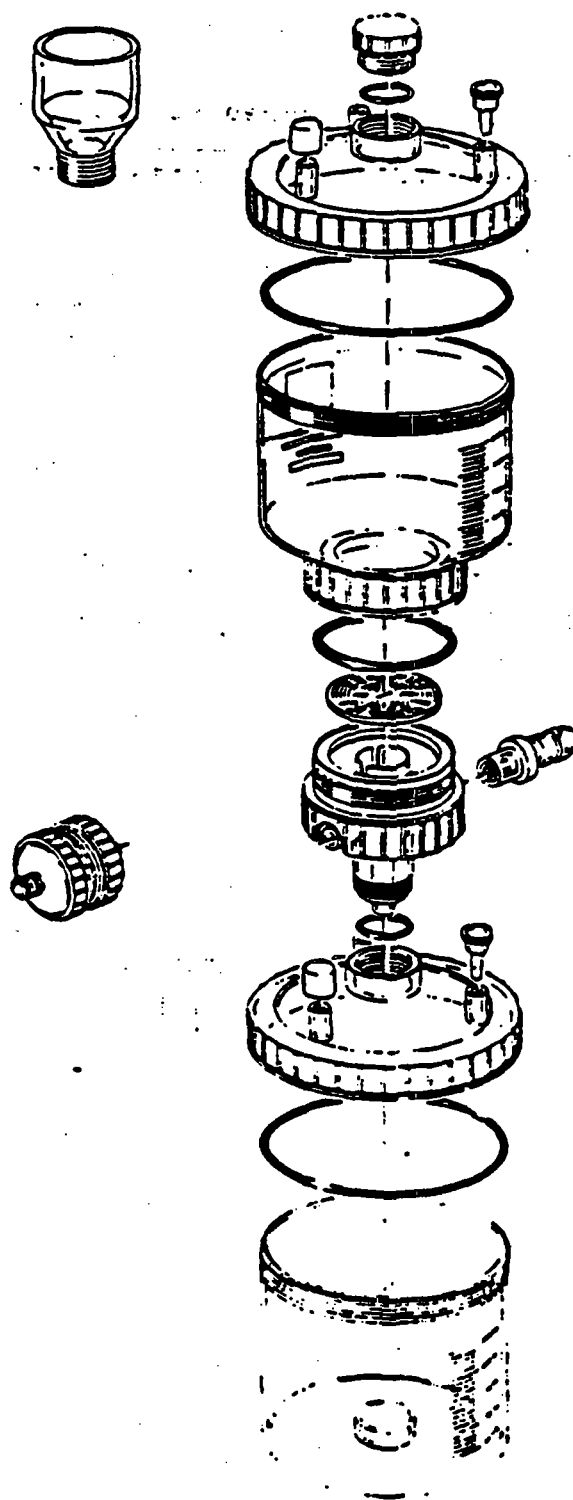


Figure 2 - Nalgene Disposable Filter Unit

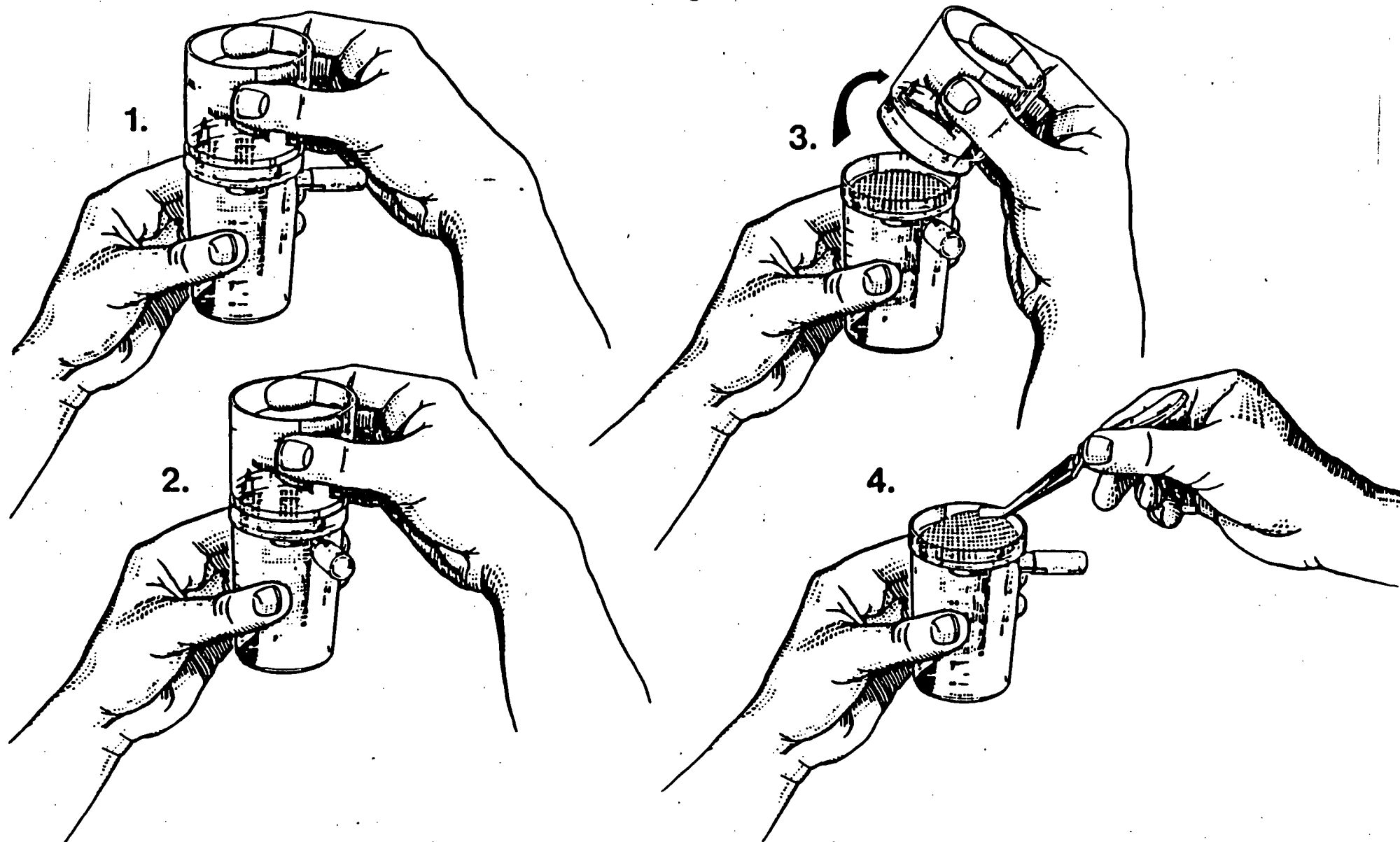
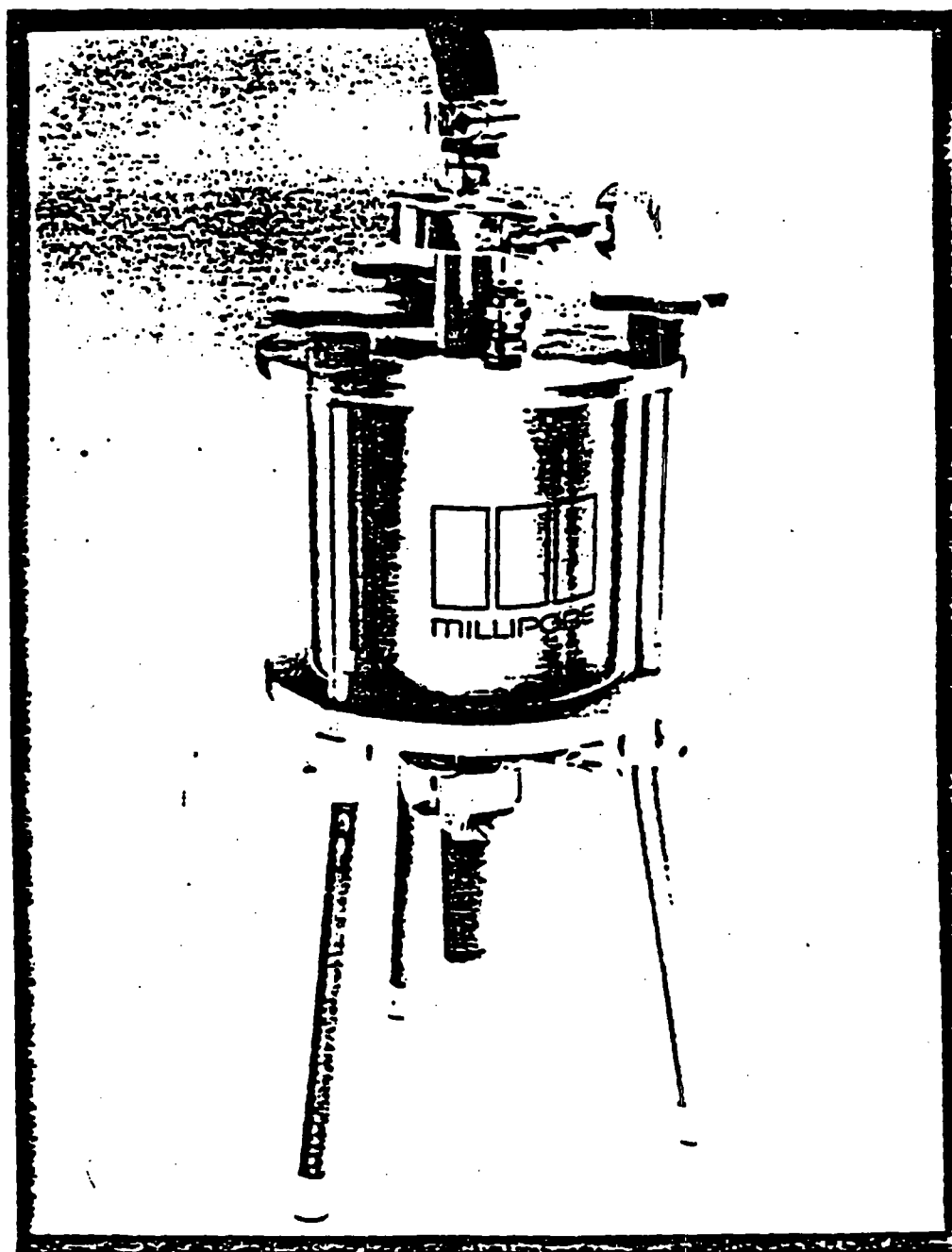




Figure 3 - Millipore Pressure Filter

HAZARDOUS WASTE FILTRATION SYSTEM



**INSTALLATION, OPERATION AND MAINTENANCE MANUAL
OM100**

is a closed system which will prevent oxidation of the sample. A .45-micron pore sized membrane should be used for sample filtration. The sample may be pumped through the filter using a standard laboratory vacuum pump or a Nalgene hand vacuum pump. The Millipore[®] pressure filter can be used where large volumes of sample need to be filtered, or the sample is extremely turbid. This pressure filter allows for rapid filtration and is constructed of all stainless steel and Teflon[®] materials. A N₂ gas sample is needed to operate it. Samples being collected for organic contaminants need not be field filtered.

In general, soil and sediment samples are not prepared in the field. However, in cases where composite samples are being collected, it may sometimes be desirable to combine and split the samples in the field. In these cases, it will be necessary to sieve the samples to remove large, non-representative fractions and then to split the same using a soil sample splitter. This procedure, however, will be extremely difficult if the soils and sediments are damp or wet. In this case, it will be necessary to return the individual aliquots to the laboratory for preparation. As stated previously, samples collected for volatile constituents cannot be composited.

4.3 Sample Preservation

It is impossible to completely stabilize every constituent within a sample. At best, preservation techniques can only retard the chemical and biological changes that continue after the sample is removed from its environment. If the sample environment is significantly different from atmospheric conditions, the sample may undergo changes which will render it non-representative of its original environment. Methods of preservation are relatively limited and are intended to retard biological action, hydrolysis of chemical compounds and complexes, and volatility. Generally, preservation methods are limited to pH control, chemical addition, refrigeration, and freezing. Table 1 gives recommended volume sizes, container types, preservatives, and holding times for a variety of standard water quality parameters. Please be aware that preservative techniques are continuously changing, and these should be routinely checked.

Sample preservation should be performed in the field immediately after sample collection and preparation. In many cases where pH control or additions of reagents are required, separate bottles and preservatives may be supplied by the laboratory. In other cases, the preservatives may be placed directly in the sample bottle prior to collection.

4.4 Sample Storage

The ideal sample bottle must be constructed of a non-reactive material. In general, there are three types of material from which sample bottles are made. These are: plastic, glass, and Teflon. In general, samples collected for metals and general water quality parameters are stored in plastic bottles. Samples collected for organic analysis are routinely placed in glass bottles of various types and sizes, depending upon the particular analysis to be conducted. Table 1 gives a list of recommended sample containers and their volumes. In most cases, bottles will be supplied by the laboratory conducting the analysis.

4.5 In-Field Measurements

As discussed previously, determination of sample pH, Ec, Eh, and temperature on ground and surface waters require in field measurements taken immediately after sample collection. Although in-field measurements are more critical for ground water samples than samples from aerated surface waters, it is recommended that measurements be taken as soon as the sample is removed from its in-situ environment. When possible, measurements may be made directly in the well to avoid the loss of sample integrity.

An alternative method for in-situ measurements is through the use of a "closed cell". This is particularly applicable to ground water measurements where pumped water can be used to fill up a closed container in which measurement probes have been previously installed (closed cell). After removing all head space from the closed cell, the cell is closed to atmospheric conditions through the use of two stop cocks. This allows measurements on ground water samples to be made as close to its original, reducing environment as it were in the formation, and eliminates error due to atmospheric oxidation of the sample.

Prior to conducting the in-field measurement, the samplers or field team must review the operating manuals for the equipment to be employed and guarantee that all of the instruments and probes are properly standardized. All measurements should then be conducted according to the procedures outlined in the appropriate operating manuals.

SECTION 5

SAMPLE PACKAGING, SHIPPING, AND CHAIN-OF-CUSTODY PROCEDURES

Once the samples have been collected, prepared, preserved, and appropriately stored, they must be packaged for shipment and/or delivery to the laboratory. In addition, from the time of sample collection until the analyses have been completed, chain-of-custody procedures must be followed to insure the proper handling and possession of the samples. This section outlines procedures for the packing and shipping of environmental samples, and general chain-of-custody procedures.

5.1 Packaging and Shipping Procedures for Environmental Samples

All individual sample containers must be placed in a strong outside shipping container. It is recommended that for this purpose a metal or styrofoam insulated cooler be used. The following is an outline of the procedures to be followed:

- Using fiberglass tape, secure the drain plug at the bottom of the cooler to insure that water from sample container breakage or ice melting does not leak from the outside container.
- Line the bottom of the cooler with a layer of absorbent material such as vermiculite.
- Place all sample containers in the cooler. Check screw caps for tightness and mark sample volume level on the outside of large containers.
- For large glass containers, packing peanuts may be used to keep containers in place and to prevent breakage.
- Small containers such as forty-milliliter vials may be placed in small plastic sandwich bags. When shipping these with large containers, steps should be taken to prevent shifting of the larger containers which might break the smaller ones.

- Cushioning material is not necessary when shipping only plastic sample containers. However, some absorbent should be included in case of breakage or leaks.
- Ice sealed in plastic bags or cool packs should be placed in the cooler when samples must be kept at 4°C.
- Documents accompanying the samples should be sealed in a ziplock plastic bag attached to the inside of the cooler lid.
- The lid of the cooler must be closed and fastened.
- Fiberglass tape should be used to seal the space between the lid and the cooler. The tape should be wrapped around the cooler several times to insure that the lid does not open if the latch becomes unfastened.
- The following information must be attached to the outside of the cooler: name and address of receiving laboratory with return address, arrows indicating "This End Up" on all four sides, and "This End Up" label on the top of the lid.
- Additional labels such as "Liquid in Glass" are optional. If the bottles have been carefully packaged, additional warnings should not be needed.
- If the cooler is not equipped with a padlock, a custody seal should be affixed and signed across the lid of the cooler.

Samples packaged in this way may be shipped by commercial air. Personnel should be prepared to open and reseal the cooler for inspection if it is required. Be aware that some commercial carriers have limits as to the number of pounds per item that can be shipped.

5.2 Chain-of-Custody Procedures

As in any other activity that may be used to support litigation, ERM must be able to provide the chain-of-possession and custody of any samples which are offered to evidence or which form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever samples are collected, transferred, stored, analyzed, or destroyed. The primary objective of these procedures is to create an accurate written record which can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence.

A sample is defined as being in someone's custody if:

- it is in one's actual possession, or
- it is in one's view, after being in one's physical possession, or
- it is in one's physical possession and then stored in a secure facility or location so that no one can tamper with it, or
- it is kept in a secured area, restricted to authorized personnel only.

The number of persons involved in collecting and handling samples should be kept to a minimum. Detailed field records should be kept in a bound log book and should contain the following information:

- Unique sample identification or log number
- Date and time
- Source of sample (including name, location, and sample type)
- Preservative used
- Analysis required
- Name of collector(s)
- Pertinent field data (pH, DO, residual chlorine, specific conductance, temperature, redox potential, etc.)
- Serial numbers on seals and transportation cases

To help eliminate possible problems in the chain-of-custody protocol, one person will be appointed Field Custodian for each investigation. For investigations where large sampling teams are used, all samples are to be turned over to the Field Custodian by the team members who collected the samples. The Field Custodian will then document each transaction and the sample will remain in his/her custody until it is shipped to the laboratory.

Each sample must be labeled using waterproof ink and sealed immediately after it is collected. Labels should be filled out before collection to minimize handling of the sample container.

Labels and tags must be firmly affixed to the sample containers. Be sure that the container is dry enough for a gummed label to be securely attached. Tags attached by string are acceptable when gummed labels are not applicable.

The sample container should then be placed in a transportation case, along with the chain-of-custody record form, pertinent field record, and analysis request form as needed. The transportation case should be sealed or locked. However, on those occasions when the use of a chest is inconvenient, the collector should seal the cap of the individual sample container with tape in a way that tampering would be easy to detect.

When samples are composited over a time period, unsealed samples can be transferred from one field crew to the next. The transferring crew lists the samples and a member of the receiving crew signs the list. The receiving crew either transfers the samples to another crew or delivers them to the laboratory.

When transferring the samples, the transferee must sign and record the date and time on the chain-of-custody record (Figure 2). Custody transfers made to a sample custodian in the field should account for each sample, although samples may be transferred as a group. Every person who takes custody must fill in the appropriate section of the chain-of-custody record form. To minimize custody records, the number of custodians in the chain-of-possession should be minimized.

The Field Custodian is responsible for properly packaging and dispatching samples to the appropriate laboratory. This responsibility includes filling out, dating, and signing the appropriate portion of the chain-of-custody record.

All packages sent to the laboratory should be accompanied by the chain-of-custody record and other pertinent forms. A copy of these forms should be retained by the originating office (either carbon or photo copy). Mailed packages can be registered with



COPIES: White-Sampler. Yellow-Lab. Pink-Client. Gold-File

return receipt requested. For packages sent by common carrier, receipts should be retained as part of the permanent chain-of-custody documentation.

Writing chain-of-custody procedures, as well as the various promulgated laboratory analytical procedures, facilitates the admission of evidence under Rule 803(6) of the Federal Rules of Evidence (P.L. 93-575). Under this statute, written records of regularly conducted business activities may be introduced into evidence as an exception to the "hearsay rule" without the testimony of the person(s) who made the record. Although it is preferable, it is not always possible for the individuals who collected, kept, and analyzed samples to testify in court. In addition, if the opposing party does not intend to contest the integrity of the sample or testing evidence, admission under Rule 803(6) can save a great deal of trial time. For these reasons, it is important to standardize the procedures followed in collection and analysis of evidentiary samples.

In criminal cases, however, records and reports of matters observed by police officers and other law enforcement personnel are not included under the business record exceptions to the "hearsay rule" according to Rule 803(8), P.L. 93-595. It is arguable that those portions of the compliance inspection report dealing with matters other than sampling and analysis results come within this exception. For this reason, in criminal cases, records and reports of response team members may not be admissible. The evidence may still have to be presented in the form of oral testimony by the person(s) who made the record or report, even though the materials come within the definition of business records.

In a criminal case, the defense counsel may be able to obtain copies of reports prepared by a witness, even if the witness does not refer to the records while testifying. If obtained, the records may be used in cross-examination.

Records are not automatically admitted in either of these actions. The business records section authorizes admission "unless the source of information or the method of circumstance of preparation indicates lack of trustworthiness". The caveat under the public records reads "unless the sources of information or other circumstances indicate lack of trustworthiness".

Thus, whether or not the team members anticipate that various records will be introduced as evidence, they should make certain that all reports are as accurate and objective as possible.